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PITMAN'S COMMON COMMODITIES
OF COMMERCE

COTTON

FROM THE RAW MATERIAL TO
THE FINISHED PRODUCT

BY

R. J. PEAKE

LONDON
SIR ISAAC PITMAN & SONS, LTD., 1 AMEN CORNER, E.C.
BATH AND NEW YORK

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PREFACE

THE magnitude of the Cotton Spinning and Manufacturing industry of Great Britain, in which it is estimated that something like £100,000,000 of capital is invested, and which employs a vast army of skilled workpeople, is colossal. Few industries have brought forth such a bountiful wealth of inventive genius—expediting and perfecting production by intricate mechanical processes, and penetrating the secrets of chemistry, bringing forth from her hidden treasuries the art hand-maidens of the textile craft. Cotton goods, in myriad styles and qualities, are found in our Home Markets, and are carried over the seas and oceans to clothe the races of the world. Obviously, a knowledge of the true sequence of the processes in this great industry is of importance. In this work I have sought to give an intelligent, technical explanation—not too technical, I hope—of the Spinning and Manufacturing Systems in their very latest forms. This description is prefaced by a short historical sketch of the more primitive method of cloth production. Particulars are given as to the growth of cotton, and the adaptability of the various staples for different counts of yarn, and this is followed by a chapter on the foundation and development up to the present time of the British Cotton Growing Association, a national movement of vast importance for our textile trade. The description of cloth production leads on to a short account of the system of merchandise. The great trade organisations of the workpeople and the Conferences between masters and men which have resulted in Treaties of Peace and the establishment of methods of

friendly adjustment of differences naturally command attention. The remarkable accomplishments of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, which has brought into one great confederation the Cotton Forces of the World, substantially promoting the friendship of nations, are presented in a close summary record. To Mr. Billington, demonstrator of Cotton Spinning at the Victoria Technical Schools, Preston, and to Mr. Mellor, cotton manufacturer and teacher of Weaving at the same schools, I wish to express my obligations for the great help they have given me in my description of the Cotton Spinning and Manufacturing processes. Finally, I owe a debt of gratitude to Mr. C. W. Macara, President of the Federation of Master Cotton Spinners' Associations and President of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, for much valuable information on the subject of organisation.

R. J. PEAKE.

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CHAPTER I

FOUNDATION OF ENGLISH COTTON TRADE

THE stupendous importance of the Cotton Trade of this Kingdom is seen in the vast amount of capital invested in the textile arts, the immense number of people employed in the sheds, factories, and works connected with the production and finishing of cloth step by step right away up from the raw material; the thousands engaged in the distribution of the finished goods in all the markets of the world, and the countless blessings conferred both on this Kingdom and on the nations of the earth by the useful and artistic productions which pour out in infinite variety from the looms of Britain. The arts of Spinning and Weaving are among the oldest in the world. Long before the days of concrete history people were vestured in woven cloths. In the Scriptures is found abundant proof that 1,700 years before Christ linen cloths were in common use. Joseph arrayed himself in vestures of fine linen. When the Tabernacle was constructed in the wilderness, two centuries later, by Moses, "The women that were wise-hearted did spin with their hands, and brought that which they had spun, both of blue and of purple, and of scarlet, and of fine linen." Almost five centuries before the Christian Era, we are told that the ordinary wear of the Indians was cotton cloths. Strabo speaks of their flowered

cottons or chintzes, and of the lustre and vivid quality of the dyes with which they figured their cloths. All over the East cloth fabrication was among the oldest of all arts, and in America it is said that the arts of Spinning and Weaving were carried on by the earliest settlers, who found the cotton and indigo plants indigenous. The first record of cotton cloths in the realms of merchandise among the rich sea-laden argosies of the East is in *The Circumnavigation of the Erythræan Sea*, in which Arrian, an Egyptian Greek, refers to the Arab traders bringing Indian cottons to Aduli, a port on the Red Sea. Ports beyond the Red Sea had an established trade in calicoes, muslins, and other cottons, both plain and bearing floral ornamentation. It does seem remarkable, as Mr. Baines points out, that a branch of industry so apt to propagate itself should have lingered thirteen hundred years on the coast of the Mediterranean before it crossed that sea to Greece or Italy, for the costly silks of China had long before been quite eagerly sought by the ladies of Rome and Constantinople. From the East the textile arts gradually spread to Europe. In Greece, in the tenth century, silks, woollens, and linens were made, and silks were made on a large scale in Southern Italy in the twelfth, thirteenth, and fourteenth centuries. There were big woollen manufactories at the same period in Flanders, Tuscany, etc., but it was left to Mohammedan Spain to cultivate cotton and to manufacture cloths from it as early as the tenth century, as well as to copy the artistic fabrications of seats of Mohammedan luxury in the East. Venice exported a variety of cottons in 1560, and Milan sent out fustians and dimities of many sorts. The first record of cotton being part of English trade is contained in a work written towards the close of the fifteenth century by Hakluyt, who says that the ships of Genoa brought from

England, among other commodities, cotton. In 1601 it is recorded that cotton was brought to England by the Antwerpians from Sicily, the Levant, and Lisbon. When the refugees from the Low Countries in the second half of the sixteenth century, fleeing from persecution, settled in England, they are said to have pursued the manufacturing arts they had practised at home. There, however, is no positive proof that the Flemish weavers, who settled in the neighbourhood of Manchester, did actually begin our English cotton manufacture. It is practically certain that many of the woven goods called "cottons" in 1552 were really woollen stuffs. As a matter of fact, for over 100 years after Roberts wrote his book on Traffic in 1641, India kept far in front of Europe in cotton manufactured goods, the East trading companies gaining great wealth by the monopoly. In 1775 a patriotic association was formed at Edinburgh to discourage ladies from wearing the cotton robes of India in preference to the calicoes and lawns of Glasgow and Paisley.

However, by the year 1727 the cotton industry had so far developed as to enable Defoe, writing on Manchester, to say "the grand manufacture which has so much raised this town is that of cotton in all its varieties." In less than fifty years afterwards there were in and about Manchester over 30,000 people engaged in the cotton industry, and the woollen and linen industries were also pursued on an extensive scale, not only here but in other parts of Lancashire. There then was laid the foundation of that industry which has built up the great wealth and industrial pre-eminence of Lancashire. In Dr. Aikin's *Forty Miles Round Manchester*, published in 1795, he says, speaking of the recently introduced cotton industry, "that in the middle of the previous century the Manchester traders went regularly to buy

fustians (a coarse cloth) of the weaver, each weaver then producing yarn or cotton as he could." Then he goes on to say that three-quarters of a century afterwards "the Manchester merchants began to give out warps and raw cotton to the weavers, receiving them back in cloth, and paying for the carding, roving, spinning, and weaving." Next there arose "second-rate merchants called, fustian-masters, who gave out a warp and raw cotton to the weaver, and received them back in cloth, paying the weaver for the weaving and spinning, and these attended the weekly market at Manchester, and the middleman sold his pieces in the grey to the merchant, who afterwards dyed and finished it." The system was primitive, but it gradually spread over the hills, dales, and plains of Lancashire, and in other places. Very many of the farmhouses and cottages had their weaving shops, and the cellars of many labouring people in the towns and villages contained hand-looms. The cotton wool was, at the outset of the system, picked by the young children, and it was then carded and spun on the jennies by the elder girls or the good wife, the yarn being woven by the father or the sons. The women of the district were sometimes engaged by the hand-loom weavers, for one efficient industrious weaver could keep three women busy turning weft off the spinning wheels. It was often difficult to get weft, and the weaver was frequently unable to deliver his cloths to the manufacturers within the time he had contracted.

Postlethwaite, in his *Dictionary of Trade and Commerce*, in 1766, estimated that at Manchester, Bolton, and the neighbourhood they made over £600,000 worth of cotton goods annually. Fustians, cottons, tapes, etc., were sent on pack-horses to London, Liverpool, and Bristol for exportation. Manchester men travelled to different parts of the Kingdom to sell cloths to the tradesmen

for home consumption. Baines tells us that "up to the year 1760 the machines used in the cotton manufacture in England were nearly as simple as those of India, though the loom was more strongly and perfectly constructed and cards for counting the cotton had been adopted from the woollen manufacture." It was clear that means would have to be taken to multiply the yarn supply, or the expanding trade was in danger of being lost. The genius of inventors was first spent in the development of the domestic spinning wheel. In 1764 James Hargreaves, of Stanhill, near Blackburn, invented his spinning jenny, which was driven by a fly-wheel, and held a number of spindles slightly inclined from the perpendicular, a movable frame receding from the spindles during the extension of the threads and approaching them in its winding on. The alarm of neighbours lest it should destroy hand labour led them to break into the house and destroy the jenny. He left the district and went to Nottingham in 1768, where a joiner named Thomas James entered into partnership with him to erect a spinning mill on the jenny plan. Before patenting the jenny he found his machine had been extensively pirated in Lancashire. He died in 1778. Crompton, the inventor of the mule, learned to spin on one of these jennies in 1769. It was in that year Arkwright, the Preston barber, secured his patent for a system of spinning by rollers, not a new idea, it is true, for a patent for a system of this sort had been taken out in 1738 by Lewis Paul, but the imperfection in mechanism prevented its general adoption. Arkwright s mechanism was much more perfect, and he and partners began a little factory at Nottingham. Arkwright's system was widely adopted and used for spinning warp and hosiery yarns of a hard and compact fabric, of any grist up to seventy or even eighty hanks in the pound,

Hargreaves' system spun soft weft yarn of rather inferior numbers, and these two independent systems for many years produced the cotton yarn of the country. The jenny gave way to the wonderfully clever invention of Samuel Crompton, of Bolton—the spinning mule. Ure says: "In the place of Arkwright's bobbins and flyers Mr. Crompton used the spindle carriage of Hargreaves' jenny to receive, attenuate, twist and wind on the threads, after their emergence from the drawing rollers." The adoption of this mule, as improved by Henry Stones, a clever mechanic residing near Bolton, was followed by developments immensely increasing the volume of production and the fineness of the yarn. About this time there was invented the billy, a union of jenny and mule, by a Stockport man. The widely adopted mule was from time to time improved by various devices. For some time roving was a distinct business in the hands of those using Arkwright's carding and roving machines. They disposed of the rove to the hand mule spinners. These inventors gave a great impetus to the factory system.

In 1771 Arkwright built a mill at Cromford, and speedily the expansion of spinning began on his principle, in various parts of Lancashire especially. Inventions to expedite cloth production began at an earlier date. In 1738 John Kay, of Bolton, invented the fly shuttle, a picking stick driving the shuttle instead of the old method of hand throwing. In 1760 Robert Kay, the son of John, invented the drop box to accommodate shuttles holding threads of various colours. In 1760 the swivel loom, adopted from the Dutch, and weaving a number of narrow pieces (tapes, etc.) at the same time was introduced. Then came the invention of the harness-loom for figured goods, and this was subsequently superseded by the Jacquard loom, with its elaborate system of

perforated cards. The commencement of the factory system began with master weavers who employed children, apprentices and journeymen. Some employers had looms on their premises and engaged weavers. From the ranks of these rugged, strong men, with the northern grit and grand spirit of self-reliance, there emerged in time some of the richest cotton lords of Lancashire and the far North; for Scotland, the land of education, progress, and lusty men, had taken up the cotton manufacture in several places at an early period. For a time the domestic system prevailed in manufacturing.

The inventions to increase the output of yarn succeeded so well that loom improvements became an absolute necessity. In 1787 the Rev. Edmund Cartwright invented the power loom, which produced more uniform cloth with far greater rapidity, but it was only adopted slowly. Glasgow made the first use of this loom at the end of the eighteenth century. In 1820 only about 14,000 power looms were in use in the United Kingdom, whilst the number of hand-looms approximated a quarter of a million. Subsequent to 1836 the power loom became rapidly adopted, and this was largely due to the economical advantage of the invention of Radcliffe and others to enable the warp to be dressed before it went to the loom, instead of the loom having to be stopped to dress the warp. The loom, too, was improved by the cloth being taken up mechanically instead of having to be pulled forward by the weaver. Other improvements, which will be dealt with later, perfected the loom to that high degree of automatic mechanism which we see in the power looms of to-day.

Following the erection in 1770 at Nottingham of Arkwright & Partners' horse-driven mill, there was in 1771, built at Cromford, in Derbyshire, Arkwright's

larger mill, driven by water-wheel (which gave to Arkwright's invention the common title " water frame "). Between 1776 and 1778 half a dozen mills were built in Oldham, three worked by horses and three by water-power. Then the mills spread over Lancashire, being often placed in the valleys to get the advantage of the water-power from the rivers and their tributaries, which transformed peaceful vales into busy and well-to-do communities. Then came the invention of Watt's steam engine, applied first in 1785 to a cotton mill at Pepplewick. It was adopted in Bolton and Glasgow, and next in Oldham. Water-power was gradually substituted by the steam engine, and there was seen more and more the concentration of factories and weaving sheds in towns and valleys. Hand-loom weaving gradually declined, the putting-out shops and the weaving rooms were closed one by one, and the stalwart, self-reliant weavers came into the towns and villages, and lived the busy life of the operative, whilst the farmers' sole business became attention to the agricultural arts and stock breeding, whereas formerly it was divided between weaving cloth and cultivating the land. It was a peaceful revolution, fruitful in blessings and prosperity. Our trade expanded in all directions, and the Exchange at Manchester became the great emporium of the world for the distribution of cotton goods, both fancy and plain. One cannot attempt to encompass in an epitome all the inventions in the mechanical arts bearing upon cotton trade evolution and expansion. We in this kingdom got the start of the world, and our home market, our colonies and possessions beyond the seas became our bountiful patrons. Production multiplied apace. Lancashire especially grew abundantly in riches and power under the textile system. Swift rail and sea transport all came in as auxiliaries of trade development,

and the huge mercantile system brought out some of the ablest, most enterprising, and most honourable men of the nation. The trade has had its periods of prosperity and depression, of strikes and lock-outs, which can only be thus generalised. It has had to face a yearly growing competition from Continental nations, and from both the Northern and Southern States of America, and even the Far East in lesser measure. The wide adoption in England of the co-operative principle has largely transformed mill ownership and stimulated industrial development. Legislation has improved the lot of the worker from time to time. Consolidation, centralisation, and specialisation are more and more yielding economical and commercial advantages. There has been a gradual co-ordination of forces. The operatives began their unions in the early days of the factory system. Then Masters' Associations were formed. Now the workpeople in the spinning, cardroom and weaving and other branches, have their separate organisations, all very powerful, and for certain objects federated. The employers have had to lengthen their cords and strengthen their stakes. They have great district Associations and a Federation, the most powerful in the world, of the Master Cotton Spinners' Associations, presided over by Mr. C. W. Macara, one of the shrewdest and most capable administrators in Europe's industrial life. The operatives spread their organised work to international proportions, bringing into line for common objects Continental operatives of all nations with themselves. The employers have followed their example, and have under the lead of Mr. C. W. Macara founded the greatest combination the world has known —the International Federation of Master Cotton Spinners' and Manufacturers' Associations, whose great historical work will be specially referred to.

The following facts illustrate the enormous magnitude of the cotton industry to-day. The total estimated number of spindles in work is as follows:

	Spindles
Great Britain	53,311,630
Germany	10,162,908
France	7,000,000
Russia	7,800,000
Austria	4,351,910
Italy	4,000,000
Spain	1,900,000
Japan	1,731,587
Switzerland	1,496,698
Belgium	1,231,165
Portugal	450,696
Holland	424,773
Sweden	450,000
Norway	75,844
Denmark	77,558
U.S. America	27,783,000
India	5,800,000
Canada	855,293
Mexico, Brazil, and other Countries ..	2,600,000
	131,503,062

The total estimated number of looms in the United Kingdom and Ireland is about 740,000. It is very difficult to estimate the number of looms abroad, on account of the large number of hand-looms still in use in some parts of the world.

Mr. C. W. Macara in 1908 illustrated the magnitude of the capital represented by the cotton trade in a speech,

acknowledging the reception of the International Committee of Cotton Spinners and Manufacturers by M. Fallières, President of the French Republic. He said:

> "To-day we have the supreme pleasure of finding that you graciously range yourself with your illustrious compeers by receiving the delegated representatives of the world-wide cotton industry, an industry which manipulates raw material in one year of the value at present prices of over £200,000,000, or five thousand million francs, and which distributes throughout the markets of the world manufactured goods of the value of £450,000,000, or eleven thousand two hundred and fifty million francs."

In his admirable address to the Cotton Spinners and Manufacturers of England and the Continent, in 1904, on a proposed International Congress, Mr. C. W. Macara, President of the Federation of Master Cotton Spinners' Associations, said:

> "It is difficult for any but those who have closely studied the statistics showing the growth of cotton spinning and manufacturing throughout the world during the last thirty years to realise the enormous development of this industry.
>
> "In the early seventies England occupied such a preponderating position that the control of the raw material was practically in her hands; this, however, has entirely changed.
>
> "It is estimated that the spinning spindles of the world now reach the vast total of 104,000,000; there are also about 5,000,000 doubling spindles and dependent machinery, such as looms, calico printing, bleaching dyeing, etc., machinery. Of these, in round figures, 44,000,000 spinning spindles, 4,000,000 doubling spindles, and dependent machinery are in

Great Britain. (Doubling is a second process in cotton spinning, and in published statistics the number of doubling spindles is usually included in the total of spindles. This method creates an erroneous impression as regards the consumption of cotton and production of yarn.) The largest proportion of these spindles is engaged in spinning the usual types of American cotton, but Egyptian and Sea Island cotton employ an increasing number of spindles every year, and, so far as these growths of cotton are concerned, England still holds the foremost position.

" It is estimated there are 60,000,000 cotton spinning spindles, 1,000,000 doubling spindles, and dependent machinery outside Great Britain.

" In addition there is still a considerable amount of hand spinning and weaving in various parts of the world.

" The published statistics regarding the cotton machinery running in England are slightly misleading, and doubtless this also applies to those in connection with the rest of the world ; allowance not being fully made for the breaking up of worn-out and obsolete machinery which is constantly going on, but this has been taken into consideration in the figures given.

" There is little doubt that the expansion of cotton machinery throughout the world has been so great that for four successive years the supply of the raw material has been insufficient to run the cotton spindles of the world.

" There is no industry in Great Britain, excepting agriculture, which affords so much employment, directly and indirectly, for the masses of the people as the manipulation of cotton, or which is of more importance to the whole mercantile and industrial system of England.

" Estimating the raw cotton at an average price of 5d. per pound, £40,000,000 worth is imported annually, an average of about £5,000,000 worth is re-exported in the raw state, leaving the balance of £35,000,000 worth of cotton to run the spindles and looms.

" This cotton, after being converted into yarn or cloth, and after undergoing one or more of the further processes of finishing, bleaching, dyeing, printing, making up into pieces, or being converted into ready-made garments, is finally packed and disposed of by the distributors at home and exporters at an estimated value, on the same basis, of over £90,000,000, leaving, as will be seen, a balance of over £55,000,000 to pay imperial and local taxation, profit on capital invested, depreciation on buildings and machinery, coal, mill stores, etc., and wages, this last item representing by far the largest proportion of the £55,000,000. The raw material is largely brought to England by British ships. When landed at the ports it forms an important part of the mercantile transactions of these ports, and the warehousing and handling of it employ a large amount of labour. The carrying of this raw material to the cotton spinning mills forms a substantial source of revenue to some of the most important railway companies and to the Manchester Ship Canal. In the further carrying of the yarn to mills engaged in the weaving branch of the cotton industry another large source of revenue accrues to the railway companies and other carriers.

" Owing to the great variety of cotton goods produced in England, the majority of manufacturers have to supply their requirements from numerous spinners, there being comparatively few mills that combine both processes of spinning and weaving.

" Again, the grey cloth has to be carried to the

warehouses of the distributors or to the works of the finishers, dyers, printers, bleachers, and ready-made clothing manufacturers; these further processes involving another rate for the railway companies before the goods reach the warehouses of the distributors, who finally are responsible for their distribution to the home and foreign markets; this again bringing in further revenue to the railway companies, shipowners, and other carriers. Like the handling of the raw material, the distribution of the manufactured products of the spindles and looms forms another important part of the commercial transactions of the nation, more especially as regards Lancashire.

"From the standpoint of employment, a study of the position is even more impressive. As already stated, the handling and warehousing of the raw material at the ports find employment for a large number of people. The repeated carrying in connection with the various processes of manufacture gives employment to a much larger section of the population.

"The cotton operatives engaged in spinning and weaving number, in round figures, 500,000. The number employed in the subsidiary industries and employments connected with cotton, already enumerated, is more difficult to estimate, but it will amount to another 500,000. Allowing two dependents only to each worker (there being a large number of young people employed) a population of no less than 3,000,000 is represented.

"There are further the dependent industries, such as the great machine-making and engineering establishments, which are largely employed with repairs, renewals, and extensions in the British cotton and subsidiary industries, also a portion of the mining

and chemical industries; all of which represent a further section of the population. The provision trade is obviously mainly dependent on the masses of the people. In any dislocation of the cotton industry its serious effects on employment generally would be widespread. But it would not end here; the retail, mercantile, banking, professional, and leisured classes would all suffer severely; and so would the landowners, property owners, and the agricultural classes, who find their largest markets in the great mercantile and industrial centres of the North of England."

CHAPTER II

THE RAW MATERIAL—COTTON GROWING

THE foundation of the textile industry of Lancashire, and other districts in which the arts of cloth fabrication have been established, is cotton, the filamentous down which invests the seeds of the gossypium, a plant of the natural order *malvaceæ* or mallows. The word cotton may be traced to the language of Arabia, a country where the plant is indigenous. Cotton was doubtless used for clothing in the very early days of human history. It was introduced into Western Europe at the era of the Mohammedan conquest. As a matter of fact it was in Mohammedan Spain that the cotton manufacture first began in Europe. Cotton is usually white, of various shades of purity; but it is sometimes cream coloured, and, in cases, iron-yellow or tawny. In recent years cotton has made great strides towards supplanting linen, and to a certain extent furnishes with mercerised yarns substitutes for wool and silk. To the uncivilised races of the world, whose needs are simpler, cotton is again most important, and all kinds of native garments, ranging from the simple loin cloth of primitive people to the elaborately decorated robes of other races, are made entirely of cotton.

Cotton was well known and in common use in India long before the Christian era, for in an old book written about 800 B.C. the plant is referred to frequently, and in such a way as to show that it was quite familiar. Nearchus, the admiral of Alexander the Great, who took part of his army along the shores of the Arabian

and Persian Gulf about 327 B.C., says: "There are in India trees bearing as it were bunches of wool. The natives made linen garments of it, wearing a shirt which reached to the middle of the leg, a sheet folded about the shoulders, and a turban rolled round the head, and the linen made by them from this substance was fine and whiter than any other." Our word "calico" was originally given to this familiar material because it came from the Indian port of Calicut. From India cotton plants were probably sent to China and other neighbouring countries.

Later explorers found cotton in other regions. For example, in 1492, Columbus noted that it grew abundantly in the West Indies and on the neighbouring coasts of America, and that the natives had considerable skill in making it up into cloth. In Mexico, Peru, and Brazil, cotton was well known and in Mexico was the chief article of clothing. In parts of tropical Africa cotton grows wild, and is used by the natives to make cloths.

The cotton plant is closely related to the ordinary wild mallows and to the hollyhocks of our gardens. Most of the species are shrubs or small trees, and in warm countries are perennial. A winter, however, kills the plants, and in the United States new plants have to be raised from seed every year. This practice is also carried out when cotton is cultivated in countries which have no winter, as it frequently gives better results than when the plants are allowed to grow for several years.

Cotton plants have large yellow, white, or red flowers, not unlike rather small hollyhock flowers, and each flower forms a capsule or "boll." When fully ripe the boll splits into three pieces, and displays the white cottony mass, consisting of a number of seeds, each

having firmly attached to it a dense covering of fine hairs, which are the raw cotton of commerce.

Cotton is distinctly a warm-climate crop, and a glance at the map of the cotton-growing regions of the world shows us that it is grown in almost every part of the earth between about 40° N. and 30° S. of the Equator. In America the principal regions are the south-eastern part of the United States, Central America, the West Indies, Brazil, Mexico, and Peru. In Europe small cotton areas are found scattered around the Mediterranean, in Spain, Italy, Turkey, and Greece. India, China, Japan, Persia, and Asia Minor are in their order the chief cotton-producing countries of Asia. In Australia cotton is only grown to a very small extent, chiefly in Queensland, South Australia, and New South Wales. Africa is an important contributor to the world's cotton supply owing to the great amount grown in Egypt; on the west coast Lagos has a considerable export, and efforts are being made to extend cotton cultivation in Nigeria and elsewhere. Rhodesia, East Africa, and Madagascar also either produce cotton or are likely to do so in the near future. Although cotton is grown in so many places, most of the world's commercial supply is obtained from three countries—the United States, India, and Egypt. The United States produce about six-tenths of the world's supply, India about two-tenths, Egypt one-tenth, and all the rest of the world together only the remaining tenth.

The different varieties of cotton demand to some degree different methods of cultivation. In some regions primitive labour and appliances alone are available; in others, such as the United States, the highest scientific and technical skill are employed. All these reasons necessarily entail differences in the mode of procedure.

Cultivation

The cotton seed is sown and the young plants thinned out to the distance apart best suited to local conditions. In about six months' time they flower, and the pods or bolls follow in due course. When ripe the bolls burst, often displaying their white cottony contents. Picking is done by hand, care being taken to harvest the cotton with as little as possible of such extraneous material as pieces of pods, twigs, dry leaves, etc.

The crop gathered is "seed-cotton," consisting of the seeds with the fibre or lint firmly attached. In primitive countries the lint is pulled off by hand. Usually, however, a gin is employed. One type of gin has rollers between which the lint passes, whilst the seeds remain behind. There are also the saw gins, in which the lint is pulled off the seeds by a rapidly rotating toothed disc or "saw." As the result of ginning, lint is separated from the seed. The latter may be used on the estate or as a source of oil. The lint is made up into bales, compressed, and is then ready for shipment, and packed up into the huge bales so familiar to all who pass along the extensive docks of Liverpool, the great cotton receiving port of England.

It is important in dealing with the raw material to note the qualities and characteristics of the various kinds of cotton which are used to produce fabrics.

The names applied to American cotton are taken from the States in which it is grown, with the exception of Uplands, Peelers, Benders, and Allenseeds.

The grade and price of cotton are regulated by the following characteristics—length of staple, fineness, strength, colour, cohesiveness, and regularity in all its features; also by the amount of leaf, sand, seed, neps, shell, and immatured fibres contained in the sample.

The average cotton crop of the Southern States of North America during the last ten years has been about 11½ million bales of 500 lb. each.

Character of Cotton

Sea Island is the longest and finest cotton grown. It has a light, creamy tinge, and is lustrous. It is grown

Photo by *Newton & Co.*

COTTON BOLLS

from small black seeds (like coffee seeds) in the Islands off the Coasts of Georgia and Florida, and to some extent on the mainland of these two States. It is used principally in making lace, gauze, imitation silk, etc., and is spun to 200's counts and upwards both twist and weft, length of staple 1·75 in. mean.

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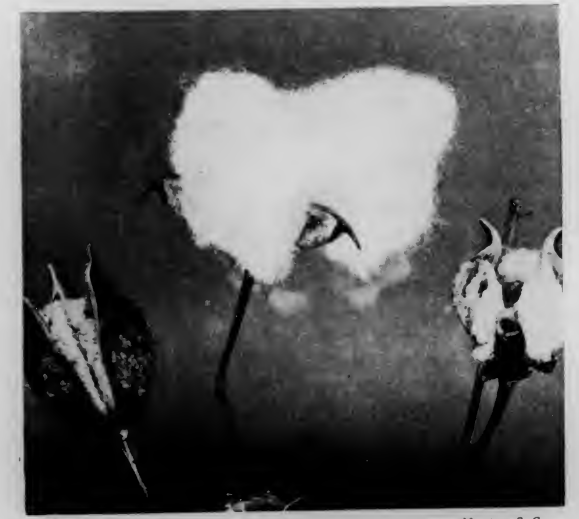

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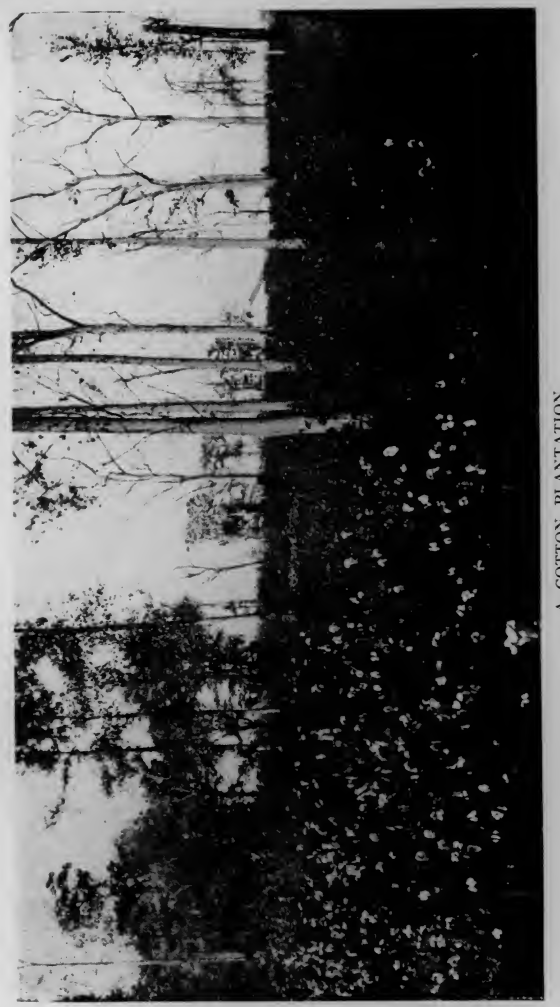

A COTTON PLANTATION

Peruvian Sea Island is somewhat whiter and shorter than the above, the mean length of staple being $1\frac{3}{8}$ in. It contains a large percentage of short fibres, and will spin up to 130's twist or weft.

The Sea Island Cotton from Queensland, Australia, is similar to Peruvian but is very little grown.

Fiji Sea Island is similar to Queensland. A peculiarity of this cotton is that it requires fresh seeds from another country owing to the deterioration of its own seed production. The new seeds are planted every three or four years.

There are three varieties of Egyptian cotton, brown, white, and gallini. Egyptian cotton as a rule has a large percentage of short fibres, especially if the River Nile is late in overflowing its banks.

White Egyptian is rather harsh, hard in staple, length $1\frac{5}{8}$ in. and is used principally for Bolton counts 80's to 90's. It is grown in the Delta of the Nile, and is supposed to have been cultivated originally from Sea Island Seeds. This cotton is used principally for sewing thread, lace, muslins, and doubled yarns.

Brown Egyptian or " Mako " Cotton, as it is called on the Continent, is soft and silky, and brown in colour, as its name implies. Length of fibres $1\frac{1}{2}$ in., spun into counts up to 150's. It is used for sewing threads, and is generally bleached. It is also used in the silk handkerchief trade.

Gallini Cotton is grown from Sea Island Seed, which was introduced in Egypt about 1840, by a Frenchman, named Jumel, and is known on the European Continent by the name of this planter. Length of staple $1\frac{5}{8}$ in., light golden colour, and is grown on the banks of the River Nile. It spins up to 200's, and is used for much the same purposes as Brown Egyptian.

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COTTON FIELDS—GATHERING RAW MATERIAL

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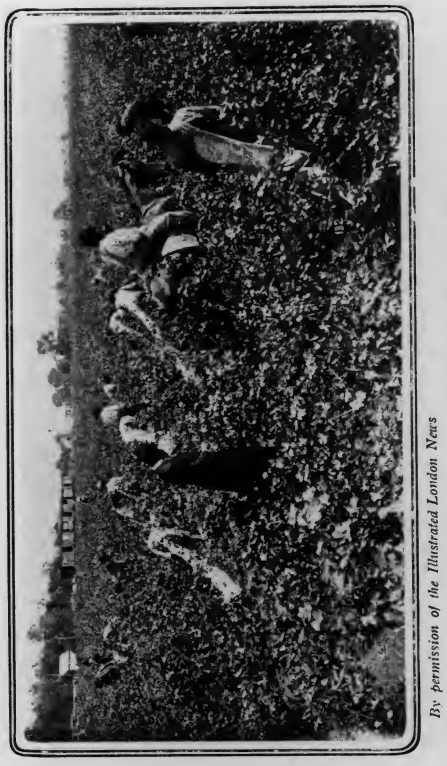

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COTTON FIELDS—GATHERING RAW MATERIAL

Gallini Cotton is now very little grown. A growth named Mit-Afifi is taking its place. This cotton ripens earlier, and is similar to Gallini in all its features.

In Egypt there are large irrigation works, consisting of reservoirs, pumping stations, and canals running through the cotton growing districts. The materials used for fertilisers are phosphate of lime, cotton seed meal, bone dust, etc.

In the Southern States of North America the cotton growing land is prepared in January and February. The seed is sown in March, April, and May, and the cotton is picked from the latter end of August to December.

In India the time for harvesting varies very much in different districts. Cotton is being picked all the year round.

In Egypt the land is prepared in February. The seed is sown in March and April, and the cotton is picked from September to December.

In Brazil the time of planting varies. Picking takes place from July to February. In Pernambuco the cotton is being picked all the year round.

The average yield per acre of lint cotton is in America 200 lb., India 90 lb., Egypt 340 lb.

South American or Brazilian Cotton is of a harsh, wiry nature, and on this account is seldom spun alone. It mixes fairly well with American Cotton, and it is occasionally mixed with Egyptian. Rough Peruvian is often mixed with wool.

PERNAMS Cotton is fairly clean, a light golden colour and harsh, the mean length $1\frac{3}{8}$ in.

MARANHAMS is a dull golden colour, weaker than Pernams and harsh; the mean length $1\frac{1}{4}$ in.

CEARAS is a dull white colour, strong, harsh, wiry, the mean length $1\frac{1}{8}$ in.

MACEIO is similar to CEARAS.

Rough PERUVIAN is a light creamy colour, harsh, wiry, fairly clean, mean length $1\frac{1}{4}$ in.

Smooth PERUVIAN is soft, smooth, flexible in comparison to Rough Peruvian.

SANTOS grown from Sea Island Seeds is white, harsh, wiry and dirty, length 1 in.

BRAZILIAN Cotton produces an oozy yarn that will carry a large percentage of size.

AMERICAN COTTON

ORLEANS, mean length of fibre 1 in. The most regular cotton grown, from pearly white to creamy in colour. It is bright, and principally spun into 30's to 40's twist, or 40's to 50's weft for the manufacture of velveteens, fustians, printers, shirtings, and domestics.

TEXAS, 1 in. length of fibre, light brown colour, rather lustrous, somewhat softer than Orleans, and hence is more suitable for weft. Used for Velveteens, Domestics.

UPLANDS, soft, pliable fibre, rather shorter than TEXAS, used only for weft.

BOWEEDS, similar to UPLANDS.

MOBILE, white, soft, pliable, used for weft, mixed sometimes with Surat. Length of staple $\frac{7}{8}$ in.

BENDERS cotton is grown on the bends of the Mississippi river. Length of staple $1\frac{1}{4}$ in. Bright, silky cotton, highly esteemed for Velveteens.

ALLANSEED cotton, length of staple 1·3 in., rather good quality.

EGYPTIAN COTTON

The ordinary Brown Egyptian Cotton is not so silky and long in staple as Sea Island. It has an average length of staple of $1\frac{1}{2}$ in. and is Brown in colour, as its

name implies. It will spin up to about 120's twist or weft. It is used largely in the doubling trade for sewing threads, and also forms the foundation for silk goods.

WHITE EGYPTIAN COTTON (or ABASSI cotton) is longer and stronger in staple than most of the ordinary Brown Egyptian, and is rather harsh and wiry. It is sometimes mixed with the Brown to give the yarn extra strength, but it also makes the yarn lighter in colour.

Joannovich Cotton is lighter in colour than the Brown; it is also rather longer and stronger in staple and is spun into higher counts.

GALLINI is the best Egyptian Cotton; it is a creamy colour, long stapled cotton grown from Sea Island seeds. There is very little of this cotton grown at the present day. Upper Egypt cotton is soft and weak, only suitable for doubling and weft yarns.

DEFECTS IN COTTON

It is extremely important in proceeding with the manufacture of cotton cloths that a thorough knowledge should be gained of defects found in cotton. The following are some of the principal: Variation in length of staple; variation in diameter of fibre; weak fibres; rough, harsh intractable staple; bad colour; insufficient lustre or bloom; large percentage of sand, dirt, leaf, shell, seeds, small pieces of broken seeds with fibre attached to them, called Bearded Motes, neps, dead and unripe fibres, also fibres with few helical twistings owing to the cotton being grown under bad conditions. All the above defects have a deteriorating effect upon the value of cotton.

The longer the staple, providing the fibres are regular in length, the finer the fibre with the least percentage of the above defects, and the higher the price of the cotton.

Boll stained or tinged cotton, sun-dried cotton, also staples which have been damaged by frost, insects, etc., have a lower value.

The strength of individual fibres varies considerably; some fibres have a breaking strain of 46 grains only, whilst others will bear 212 grains before breaking. From this statement it will be seen that only a small percentage of the actual strength of the fibres in any cross section of yarn is utilised in offering the resistance to breakage, so that much depends upon the twisting together of the fibres so as to prevent actual sliding of fibres over each other when a thread breaks.

The testing of cotton fibres is often done by pulling the staple by the fingers, which gives a simple means of arriving at the commercial value of any sample of cotton.

Microscopical tests are useful in comparing the relative spinning qualities of cotton, as it can then be seen whether the fibre possesses many helical twistings or not, and whether the fibres are dead, undeveloped, or unripe, owing to being grown under unfavourable conditions.

Other tests, such as burning the fibres and threads, are sometimes used to ascertain if yarns contain cotton, wool, or silk. The difference in the smell of these fibres when burning is easily distinguishable. Owing to cotton being a vegetable and wool an animal fibre, it is possible to dissolve the cotton fibres from any woollen yarn or fabric.

The following is the average weight and density of cotton bales:

Egyptian	about	700	lbs.	Density	34	lbs. per cub. ft.
American	,,	500	,,	,,	24	,,	,,	,,
East India	,,	400	,,	,,	30	,,	,,	,,
Brazilian	,,	250	,,	,,	20	,,	,,	,,

Preparing Cotton for the Market

The preparing of cotton for the market is a work of growing importance. In 1906 there was appointed in Lancashire a Private Investigation Commission to visit the cotton growing area of the United States of America, to ascertain on the spot the cost of growing cotton and the economic conditions under which it is produced in the cotton belt. The Commission was also charged with the investigation of the methods of ginning, baling, handling, marketing, and transport of the product. After a close scrutiny a perfect knowledge was obtained of the economic conditions surrounding the growth of cotton. It was found that it was not so much on increase of acreage, important as that is, that the potentialities of the States lie, as on seed selection, fertilisation and crop cultivation. As a result of the visit of this Commission a great improvement in baling the cotton is noticeable. Compressed, well-wrapped bales yield a great economical advantage over the old loose and wasteful system of baling, and in the cost of handling and transport, there is a great saving effected. The cotton from the various belts and fields of the world is shipped to the great ports adjacent to the textile industries. In this kingdom, Liverpool is the great market. The members of the firm, or manager responsible for the spinning, goes to Liverpool and buys on the spot the exact character of cotton he requires. If he finds that a recent purchase was not quite suitable in grade or staple he is able to select cotton of a higher or lower grade, as the case may require. The Spot Market enables a Lancashire mill manager to buy cotton exactly to his needs. In America there is no Spot Market. The treasurer of the mill buys the cotton from merchant's samples in large quantities, which are then warehoused at the mill. The value of a Spot

Market in this kingdom enables the spinner to do without carrying a large stock and to buy exactly what he wants from time to time.

Development of British Cotton Growing

The United States control the cotton market and any diminution in the supply from this source, due to a short crop, or to the artificial manipulation by speculators, entails grave consequences to the vast cotton industry of Lancashire. Such a shortage was brought about by the American Civil War in 1864, when cotton reached a very high figure and much distress was caused in England. Again in 1902 there was another shortage in the supply from America, which was made worse by the action of speculators endeavouring to form a "corner" in cotton. Later still there was great industrial loss and dislocation by the perils of shortage and great speculations, and it became imperative that Great Britain should try and protect herself from these calamities by founding and developing cotton fields in her own Dominions and Dependencies.

The movement for developing the cultivation of cotton in British Territories originated at the annual dinner of the Oldham Chamber of Commerce, held in January 1901, when a discussion took place on the necessity of securing increased supplies of cotton for Lancashire spinners, and at a subsequent meeting a Special Committee was appointed to make enquiries into the possibilities of cotton growing in different parts of the British Empire. In the report of this Committee, which was presented to the Oldham Chamber on November 18th, 1901, it was pointed out that suitable cotton for the Lancashire trade could be grown in various parts of the British Empire. The other Chambers of Commerce were then approached

with a view to supporting the movement, and a meeting was held at the Manchester Chamber on February 18th, 1902, when an influential committee was appointed. In the meantime, the late Sir Alfred L. Jones, K.C.M.G. (the head of Messrs. Elder, Dempster & Co.), had been working in the same direction by sending out a supply of American seed to West Africa, and impressing upon the Governors of the West African Colonies the necessity of endeavouring to extend the growth of cotton. A meeting took place in Manchester on June 12th, 1902, when the British Growing Association was formally inaugurated, and an Executive Committee appointed, and it was decided to raise a guarantee fund of £50,000.

In November 1903, it was decided to increase this guarantee fund from £50,000 to £100,000, and in January, 1904, the situation became so much more serious, owing to the operations of Mr. Solly, and others, that it was resolved to increase the fund to £500,000, so as to enable the work to be more rapidly developed in those Colonies where substantial results could be obtained. It was then decided to have the Association legally constituted, and the Royal Charter was finally sealed on August 27th, 1904.

The authorised capital of the Association is £500,000, of which rather more than £261,000 had been subscribed up to 1909, but in 1910, by a special effort a large part of the authorised capital had been raised.

Progress of the Work

West Africa. In the Colony of Lagos good progress has been steadily maintained from the outset, with the exception of the year 1908, which showed a decrease in the production owing to a serious drought during the growing period of the crop.

The following statistics will show the steady increase

in the production of cotton in Lagos during the past few years:

1904	1905	1906	1907	1908	
2,157	3,196	6,740	10,224	5,410	bales

During 1909 the production up to the present time amounts to nearly 12,000 bales.

In Northern Nigeria the rate of progress has not been so rapid as could be wished, but the extension of the railway to Kano will open up new agricultural districts, which are well populated, and between Zaria and Kano it is stated that 50,000 to 80,000 bales of cotton are already being produced each year and used locally. The quality of the cotton from Northern Nigeria is excellent, and it commands a ready sale in Liverpool, at prices well over Middling American.

Uganda. The development in this Protectorate has been most encouraging, and it will be seen that the natives have taken up cotton growing seriously when the estimates of the crop during the past three years are considered, viz.:

1906	1907	1908
500 bales	2,000 bales	5,000 bales

The Right Honourable Winston S. Churchill, M.P., reported, on his return from East Africa last year, that in Uganda alone there were over 20,000 square miles (12,800,000 acres) suitable for cotton cultivation, and that there were more than one million farmers there.

Nyasaland. Notwithstanding the losses which were sustained in the initial stages of the industry in Nyasaland, and which were caused in a great measure by

lack of knowledge on the part of the planters, cotton growing has made great headway, and it has been established that cotton of a superior Upland type can be successfully grown in the highlands. Those planters who have continued the cultivation of cotton are among the ablest and most successful men in the Colony. Every encouragement is being given to the natives to cultivate cotton, and with some degree of success.

WEST INDIES. The cultivation of Sea Island Cotton is now an established industry throughout the Islands. The finest quality of cotton is grown in St. Vincent, where the soil, climate, and general conditions are more favourable for the production of the finest qualities of cotton than in any of the other Islands.

The following is a statement showing the quantity and value of raw cotton exported from the different Islands in each of the years ending December 31st, 1904, to 1907 :

NUMBER OF BALES

	1904	1905	1906	1907
St. Lucia	6	4	2	—
Bahamas	21	17	33	21
Jamaica (*a*) ..	36	220	48	16
St. Vincent (*a*) ..	315	345	658	1,070
Barbados	480	861	1,209	2,368
Grenada	786	532	778	713
Leeward Islands ..	290	982	1,401	2,335
Trinidad and Tobago (*a*)	4	37	28	28
Total ..	1,938	2,998	4,157	6,551

(*a*) For the twelve months ending March 31st

VALUE

	1904	1905	1906	1907
	£	£	£	£
St. Lucia	90	52	40	—
Bahamas	179	119	274	234
Jamaica (*a*) ..	546	3,501	952	320
St. Vincent (*a*) ..	4,494	7,674	18,169	30,787
Barbados	9,593	17,212	26,006	83,362
Grenada	7,348	2,720	6,702	6,352
Leeward Islands ..	5,709	22,539	31,276	76,783
Trinidad and Tobago (*a*)	70	434	286	280
Total ..	£28,029	£54,251	£83,705	£198,118

(*a*) For the twelve months ending March 31st

CHAPTER III

THE SPINNING MILL

In most of the spinning mills of this Kingdom cotton is spun for sale as yarn; in others, owned by manufacturers, twist and weft are produced for consumption in the weaving sheds, the surplus yarn being sold or the deficiency made up by purchase. Good management is indispensable to success. The sequence of processes down to the minutest details must be perfectly familiar to the manager, who has to be able to so co-ordinate the productive system that the greatest weight of yarn is got off within the hours of running, at the least cost, quality of staple, of course, being a dominating factor. The managers and overlookers of the present day are technologically trained in the institutes and textile schools, which have become part of our educational system. The erection of a spinning mill is an expensive undertaking, and may be roughly computed to cost about 25s. per mule spindle. The wages of the operatives in the cleaning, carding and spinning departments are in most cases arranged between the masters' and the workpeople's organisations, and the British cotton operatives are absolutely unrivalled for manual dexterity, intelligence and efficiency. Localisation of particular industries is among the phenomenal of British industrial life. For instance, the Manchester and Bolton districts hold the predominance in fine spinning, though the production of fine counts of yarn has somewhat rapidly proceeded of late years in other towns—Oldham, Preston, etc. The Oldham and South-east Lancashire cotton towns are the greatest industrial areas of England

in which American cotton, from which medium counts are spun, is consumed. Like good fruits, yarns improve with a certain amount of keeping.

Yarn kept for some days in a damp cellar or conditioning room improves in strength and working qualities generally. The natural tendency to snarl is taken out of the yarn, and it is thus rendered easier to handle at the next process. The natural moisture extracted during the opening operations is also returned to the fibres in the conditioning room. In yarn, strength, evenness, elasticity, and good colour, are essential.

The following cotton mixing table for first-class qualities of yarn will be of value:

Under	12's	Twist Bengal Sind broken up cop bottoms, Fly and strips from card.
,,	15's	,, 1 Bengal, 1 Smyrna and 1 Chinese, either separate or mixed together.
,,	20's	,, 1 Dharwar, 1 Dhollerah or Oomra or Tinnevelly, or lower grades of American.
,,	30's	,, Better grades of Indian with the strong low classes of American.
,,	40's	,, The Middling grades or Texas mixed with Rough Peruvian or any Brazilian cotton in small proportions, never more than one-third.
,,	50's	,, Good Fair Brown Egyptian or higher grades of American cotton, mixed with not more than one-third Maranhams, Santos, Pernams.
,,	60's	,, Fully good fair brown Egyptian.
,,	80's	,, Good brown Egyptian alone or mixed with Joannovich or very good Abassi. Brown Egyptian is often spun alone

owing to its colour. When mixed with other cotton there is a danger of producing pinrowed, striped or streaky yarn.

Under 90's Twist Combed Brown Egyptian, Joannovich or Abassi mixed.

,, 100's ,, and Upwards, Combed Sea Island.

Weft Counts would be spun one-fourth finer than twist from same mixing.

When it is intended to bleach the goods in which the yarn is used, the colour of cotton is of no moment. Yarns made from waste are always used for weft.

To test the quality of a mixing, one may take a vertical section of the stack so as to get an even lot. Pass it through every spinning machine in the mill, then test the yarn and compare it with the standard quality generally kept in stock to see that it is up to the required strength, colour, cleanliness, counts, etc.

To test cotton and yarn for moisture, it is usual to weigh about 100 lb. and dry at about 100° F. This is generally done in the boiler or engine house for one or two days. Afterwards it is put in a room for a day at about 75° F. to regain its natural moisture. Then it is weighed again. If it is then found to have lost more than 3 lb. or 3 % it is evident that moisture has been artificially added.

A special oven is now used for drying yarn and cotton when testing for moisture.

We will assume that cotton has been bought at Liverpool to suit the needs of the spinner, and that the bales are duly delivered at the mill.

Let us proceed to the first treatment of the raw cotton. After it is delivered to the spinning mill, the

bales are weighed and a few of them opened and examined to see if they are right in quality, according to the sample from which they have been bought. The mixing together of different varieties and staples of cotton is essential in order to get the average quality of the cotton used. Mixing, too, brings about more uniformity in the quality of the yarn. Cotton of long, strong, and cohesive staples is best adapted for twist, and cotton possessing these spinning qualities in a less degree, is used for weft.

A twist yarn forms the foundation of the cloth and has to stand the strain put upon it in winding, warping, sizing, and weaving, and on this account it has to be a strong, smooth, cohesive yarn. A weft yarn forms the covering or " feeling " for the cloth and requires to have a soft, silky, oozy feel and appearance. It is not necessary for the weft to be as strong as the twist yarn because the former is taken direct to the loom and is subjected to very little strain.

There are two ways of mixing : (1) by the hand, or (2) by machine. In the latter case a certain amount of cleaning is secured by the action of the machine. In the former there is no cleaning. The advantage of hand-mixing is that you get the cotton better blended, and thereby secure more uniformity in the quality of the yarn, but the cost of production is increased thereby.

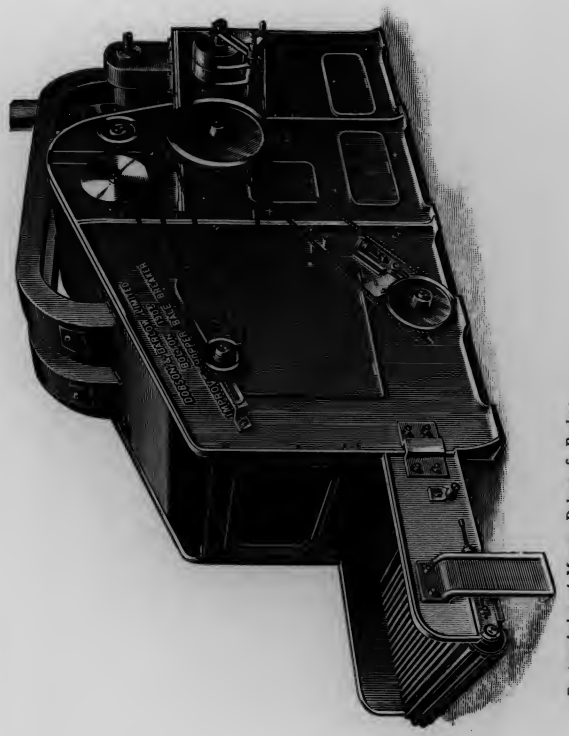
Bale Breaker or Mixing Machine

If the cotton is mixed by machine it will be done either by the Roller Bale Breaker or Hopper Bale Breaker. The latter machine has largely superseded the former, as it opens and cleans the cotton better and more cheaply. The Hopper addition to mixing and scutching room machinery is the greatest

improvement made in recent years. The Hopper Bale Breaker is very strongly built, and consists of a Hopper box into which the feed lattice drops the cotton. Or large armfuls may be thrown direct into the Hopper box, at the bottom of which is a short floor lattice which delivers the cotton to an inclined spiked lattice moving upwards at about an angle of 35° from a vertical line. The spikes of this lattice take hold of the cotton and carry it upward. Near the top of this lattice is an evenning roller, which combs out any large pieces. At the rear of the spiked lattice is a stripping roller which clears the lattice, the cotton falling on a short lattice near the bottom of the machine. This carries the cotton to a pair of inclined or vertical lattices which presses the cotton between them. These lattices carry it upwards and drop it on another lattice, from which, by other lattices and a reversible arrangement, it can be distributed to any part of the mixing room. There may be as many as six mixings in the room.

Cotton Opening

The mixed cotton is taken from the stack, in vertical sections, so as to get mixed in every armful a small portion of cotton from each bale. This is with the object of securing uniformity in the yarn. A mixing that will last a week is preferred to one that will last a day, and whilst one mixing is being used another is in process of making. This gives time for the evaporation of any dampness that may be in the cotton. The cotton from the mixing is generally placed upon a travelling floor lattice of sufficient length to suit local conditions. This carries the cotton forward into a Hopper feeder box. The object of this feeder is to pull the cotton finer and to clean it a little, but principally to deliver



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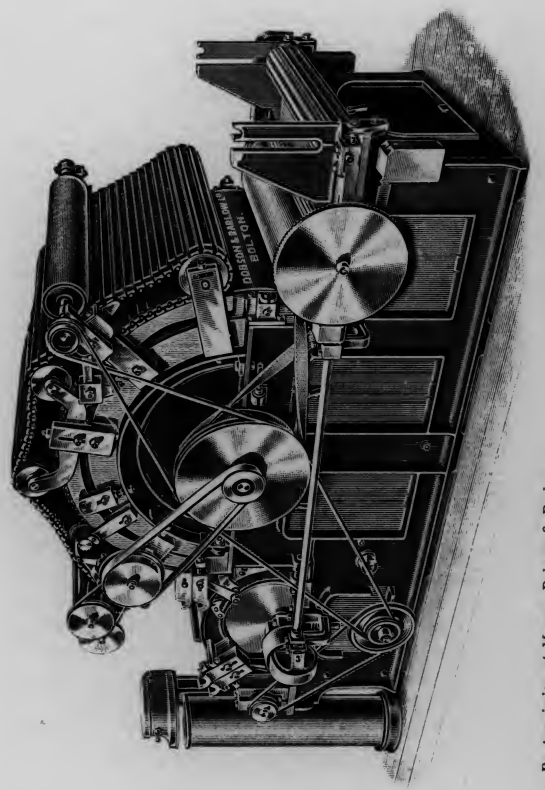
BALE BREAKER

it upon the Porcupine Opener feed lattice in an even sheet. The feed lattice carries the cotton to a pair of feed rollers, from which it is struck by a Porcupine cylinder about 36 inches diameter and 45 inches wide, and run at about 500 revolutions per minute. The force of the blow given to the cotton by the beater drives it against dirt bars, set in a circular position underneath the beater. Whilst dirt is driven out the cotton is carried forward by the strong air current through dust trunks. If damp cotton is placed in the opening machines it causes them to choke up, and also tends to string, and nep the cotton, whilst the dirt does not come away as when the cotton is in a dry state.

The dust trunks are about four feet long, 12 inches wide, and ⊔ shaped. As the cotton passes through, the dirt falls down between thin plates. At the base of the trunks there are hinged air-tight doors which are opened once or twice a day to remove the accumulations. There are generally about half a dozen of these dust trunks or dirt boxes in the range between the Hopper and Opener, the number varying according to the space available. From the trunks the cotton enters into another beater chamber, where another beating and cleaning process goes on. Then it is collected by a pair of dust cages, drums made of perforated sheet metal, on fine meshed wire netting. The ends of the cages are open to a dust flue, down which a fan forces a strong air current. This produces a partial vacuum inside the cages, causing the cotton to fly on the outside of the cages, whilst the fine dust and impurities pass through the perforations into the dust flue below. It is important that the construction of the flues offers no obstruction to the passage of the air. The dust cages pass the cotton on to pairs of cage rollers, and then on to one or two pairs of feed rollers, from which it is struck



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REVOLVING FLAT CARDING ENGINE

by a two or three-bladed beater revolving at a rapid rate. A two-bladed beater revolves at about 1,300 revolutions, and a three-bladed beater at about 900 revolutions per minute. These beaters are very carefully made, well finished, strong, and perfectly balanced. The edges of the striking blades are bevelled to a point, so as to open and clean the cotton better. After these beaters have been working a number of years the bevel edge gets worn off and has to be resharpened or replaced. For the finer and better qualities of cottons some prefer the three-bladed beater for the reason that you get the same number of blows given to the cotton per minute as you do with a two-bladed beater, and the force is therefore less. This is an advantage for finer cotton.

The beater strikes the cotton against the dirt bars. The dirt, being heavier than cotton, takes up a greater percentage of the energy of the blow given by the beater and is consequently driven out. The cotton is carried forward by the air current rushing through the spaces in the dirt bars and delivered upon a second pair of dust cages, which collect the cotton into sheet form. Then it is passed on to the cage rollers and calender rollers consolidating the sheet so that the liability of " licking " at the next process will be less. From the calender roller the cotton sheet is delivered to the lap rollers, which wind it up into lap form and by means of a lap-compression motion, which consists of a rack, train of wheels and brake-pulley, the lap is wound up very tightly and is easy to handle at the next process. The production of a Hopper Bale Breaker is very great.

The production of a Hopper Feeder is the capacity of the opener to take the feed and amounts to about 30,000 lb. per week of fifty hours.

The Scutcher

The object of the scutcher is to further clean and open the cotton, and also to improve the regularity of the opener laps. It used to be a common practice to have an intermediate scutcher for American cotton, but since the introduction of the Hopper Feeder, the intermediate scutcher is not considered necessary. The less you can beat and work cotton, so long as you get it clean and sufficiently opened for the card, the stronger yarn you get.

The Opener lap, which generally weighs about 40 lb., and is about 45 yards long, is put upon the feed lattice of the scutcher. Generally four laps are doubled. This helps to make the finished lap more uniform in weight yard per yard. The doubled laps are fed to two pairs of feed rollers, or one pair of feed rollers and another roller with pedal levers under the roller which forms part of the piano-feed motion. From these rollers or pedal nose the cotton is struck by a heavy revolving beater. Dashed against the dirt bars, the impurities in the cotton fall through. The cotton collected by a pair of dust cages, passes to a pair of conducting rollers, and four lines of calender rollers, which compress the sheet of cotton, after which it is wound up in lap form ready for the carding engine.

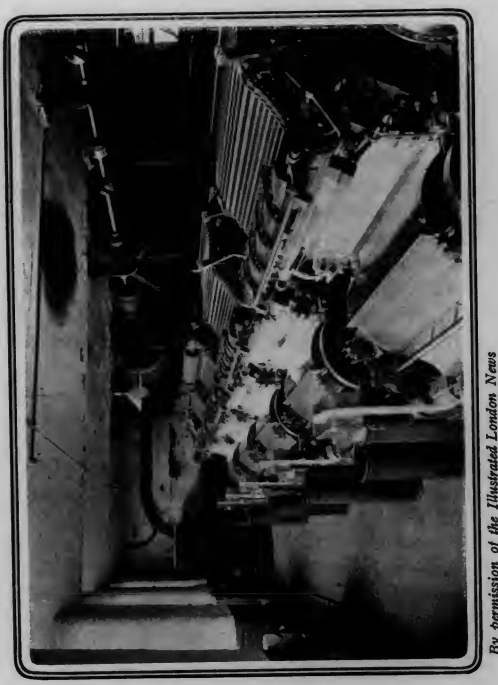
There are several motions about a modern scutcher which require dealing with separately, such as the piano-feed motion, knocking-off or measuring motion, the arrangement for weighting the calender rollers, and the driving of the different parts of the machine.

Piano-feed Motion

The object of this motion is to regulate the speed of the feed rollers to compensate for any variation there may be in the thickness of the opener laps. The motion

consists of a feed roller, under which are placed a number of pedal levers. The nose of the pedal is specially shaped (if the cotton is struck from it) to suit the length of the fibre, so as not to damage the cotton. If the cotton is not struck from the pedal nose, but from a pair of feed rollers, then the regulating pedal is placed behind the feed rollers and does not need to be specially shaped at the nose. Whichever may be the case, the pedal lever is fulcrumed several inches from the nose. The tail end of the lever, of which there are about sixteen, is hooked, so as to hold a vertically hung pendant lever, the lower end of which is wedge-shaped △. These wedge-shaped parts hang between antifriction bowls. The end pendant is slotted and to it is connected a lever which, through a connection of levers, acts and moves a leather belt which drives the feed roller through a train of wheel and cone drums. If a thick place in the lap comes under the feed roller it depresses the pedal lever, swivels round the fulcrum, lifts up the tail end, which also raises the pendant lever, and through the bowl box to the last lever in the series and onwards, to the cone drum belt, thus moving the position of the belt on the cones to drive the feed roller slower and compensate for the extra thickness going through. If a thin piece is going under the feed rollers the opposite effect is obtained. The feed roller is speeded up to neutralise the thin place.

The greatest defect in connection with the piano-feed motion is the trouble of having to clean the bowl box out every few weeks, also the bowls sticking and flat places wearing on them. If the bowl box is not kept clean and the bowls in good condition, there is neutralised the object of the motion. Many different arrangements of bowls have been tried with a view to reducing friction in the bowl box, and a few years ago one important



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CARD ROOM, SHOWING MOTOR

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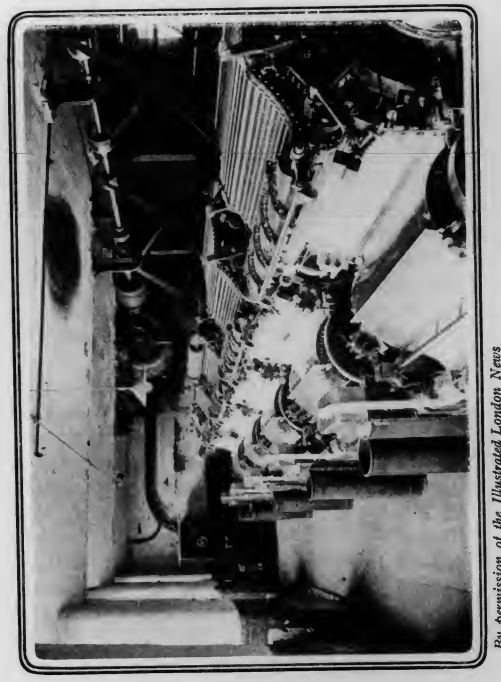

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CARD ROOM, SHOWING MOTOR

machine-making firm introduced an arrangement to discard the bowls and bowl-box altogether, and substitute a tripod arrangement of levers and links. This method has had a very wide adoption and is giving satisfactory results.

In some of the old scutchers there were two calender rollers, but in all modern machines (unless specially ordered) there are four calender rollers. The four calender rollered machines give better consolidation to the laps. The calender rollers are also made with a slightly different surface speed so as to polish and smooth the consolidated sheet of cotton. It is important that all lap rods used for laps should be exactly the same weight. If they are not, one is led astray in weighing the full laps.

On most openers there is a knocking-off motion, but this is not used when there is a pressure for laps, thus increasing the production of the machines. The finished laps at the scutcher weigh about 30 lb. each, and any lap weighing 4 oz. lighter or heavier than this standard weight should be rejected for irregularity. In some cases these bad laps are sent back to the mixing room, or a heavy and light lap may be put on the creel of the scutcher lattice again and made into a fresh lap.

It is not absolutely certain because the total weights of the laps are equal that they are good laps. Generally speaking, this would be so. At the same time, it is possible the total weight of the lap is right, but the lap yard per yard very irregular. Owing to this being possible, there are wooden gauges for measuring off two-yard lengths. The whole lap is sometimes measured in two yards and re-weighed. If the lengths then weigh equal it is proof that the machine is working well.

In both scutchers and openers it is important that all

parts should be kept well oiled and cleaned. If this is not properly attended to there is the liability to fires, irregular laps, lap-licking or splitting, and bad selvedges. All parts of the machine with which the cotton comes into contact should be periodically black-leaded, to make them smooth, so that the cotton may not adhere.

Carding

The object of the carding engine is (1) to remove all impurities either natural or foreign in the cotton which have escaped the preceding processes ; (2) the extracting of all short, immatured, broken or nepped fibres, the retention of which would weaken or otherwise reduce the quality of the yarn ; (3) to disentangle the confused mass of fibres and lay them approximately in parallel order ; (4) to attenuate or draw out the heavy sheet of lap into a thin fleece or film and contract it into a ribbon of cotton or sliver, fitted for the next process.

The impurities are husks, shell, seeds, bearded motes, leaf, neps, and dead or unripe cotton. The whole, or most of these impurities, are forced into the card wire, and periodically stripped out by a comb, working in connection with the flats. A brush strips the impurities from the cylinder and doffer. The short fibres not being of sufficient length to be held by the card teeth are thrown off, in the flat-teeth, or through the undercasing of the licker-in, or cylinder.

The drafting and the collecting of the fibres from the doffer, and guiding them through a funnel, and calender rollers, constitutes the making of the web into a sliver.

Bearded motes, neps and leaf are the impurities most difficult to extract in the card. Bearded motes are unginned broken seeds, and broken seeds which have

short hairs on them after ginning. The short hairs on the outside of the broken seeds stick to the cotton and are difficult to extract.

Neps are a small number of fibres rolled together, forming a ball about the size of a pin-head. These neps may be caused by bad ginning, overbeating at the scutchers, or bad carding, and they adhere to the cotton tenaciously.

Leaf is very light, breaks up into fine pieces, and is very difficult to get rid of. It is only by subjecting the cotton to the process of combing that perfectly clean yarn is obtained.

Many years ago there used to be a system of double carding. This is now obsolete and has been superseded by the Revolving Flat Card and the Comber. The Revolving Flat Card gives double the production to that of a Roller and Clearer Card, with a better carded sliver, more cheaply produced.

Let us now see how the cotton lap is further opened and cleared in passing through a Revolving Flat Card.

The scutcher lap is placed upon a fluted lap roller. The end of the lap is guided under a feed roller about 2 inches in diameter. Under the feed roller is a dish-feed plate, the nose of which is curved to suit the curvature of the feed roller, and the length of the nose is made to suit the length of the fibre being carded. Whilst the cotton is held by the feed roller and dish-feed plate, the cotton is combed out by the teeth of the licker-in, the points of which are set to about $\frac{7}{1000}$ of an inch from the nose of the dish-feed. At this point the material is attenuated or drafted out about 2,000 times. so that the lap sheet is converted into a very thin fleece, Underneath the licker-in are two mote knives for clearing off the fragments of seeds on the surface of the

fleece of cotton being carried round. On the points of the teeth of the licker-in, there are also dirt bars, where fine impurities and short fibres pass through into the dirt chamber below. The cylinder has about double the surface speed to the licker-in, and its wire teeth are bent forward in the direction of motion, and set to about $\frac{7}{1000}$ of an inch from the licker-in teeth. The cylinder strips the licker-in of its fibres and carries them on to the flats. Generally there are about 110 flats on a card, and forty-four of these are always carding, when the card is working. The flats wire has what is called a heel and toe, when carding. The wire where the cotton enters is about $\frac{1}{50}$th of an inch from the cylinder wire and is called the toe. The heel is where the cotton leaves the flat and is set to about $\frac{1}{100}$th of an inch from the cylinder wire. The object of this heel and toe in the flat wire is to allow the cotton to enter under the flat easily without rolling and forming neps, and the heel being nearer the cylinder wire gives the fibres a progressive carding. The flats are the main carding part of a carding engine. As the cylinder carries the fibres under the flats they tend, through centrifugal force, to fly out, and in doing so come in contact with the flat teeth which combs and cleans the fibres from many of their impurities. After the cotton has passed under the forty-four flats it comes to a stripping plate, which separates the fibres as they leave the flats. Very much depends upon the setting of this plate whether there are heavy or light strips. The nearer this plate point is set to the cylinder wire, the lighter the strips will be. The cylinder carries the cotton onward to the doffer, which has about thirty times less surface speed than the cylinders. It runs in the opposite direction to the cylinder, and its wire teeth are set in an opposite direction to its motion. It is set to about $\frac{5}{1000}$ths of an inch from the cylinder wire and

collecting the fine web from the cylinder, carries it underneath to the front, where it is stripped by an oscillating comb set close to the wire teeth. It is next guided to a trumpet mouth, which condenses the web into a cotton sliver. Then it passes through a pair of calender rollers and coiler rollers, down the tube wheel, and is wound spirally into the sliver can which runs in the opposite direction to the coiler and at a much slower speed. The variation in speed and the setting of the can-plate in relation to the coiler winds the material into the can, in a very beautiful manner. The object of winding it in, after this fashion, is to get a greater quantity of sliver into the can, and to enable it to be pulled out at the next process without entanglement and breakage.

The filleting for the card is made in lengths so that one length will cover the doffer or cylinder. The foundation of the filleting for doffer and cylinder is generally made up of one layer of woollen sandwiched by two outside layers of cotton cloth of very good quality. These layers are securely cemented together by india-rubber cement and finished off with a top layer of pure india-rubber. The object aimed at is to get a firm foundation for the wire and at the same time to have a little elasticity in it. For the flats there is used the same foundation but without the layer of india-rubber at the top. It would not do to use the india-rubber for flat foundation, because the flat has no protection from the rays of the sun. The cylinder and doffer are more protected and cased-in than the flats.

Section of Card Wire

Many different sections of card wire have been tried for card clothing, viz., round, plough ground, flat, side ground, convex, etc. All the sections, except round

and plough ground, have been discarded because of their weakness and working loose in the foundation. The object of these different sections is to supply a wire that will keep sharp at the point without having to be ground frequently, and also to provide more space between the wires for the accumulation of dirt, and thus reduce the need for frequently stripping out. Experience has proved that plough-ground wire (that is, wire of a round section, but ground down, the tooth almost to the knee) is all that is desired, though some people using the better qualities of cotton prefer the surface ground—that is, wire of a round section with the sides close to the face of the wires ground to a point.

The counts of card wire are based on the number of points in one inch length, and four inches width of the filleting. If you divide the number of crowns per square inch by $2\frac{1}{2}$ it equals the counts of wire.

Counts × $2\frac{1}{2}$ equals Crowns per sq. inch
,, × 5 ,, points ,, ,,

so that if the counts of card clothing are 100's we should have 500 per sq. inch.

The counts of wire used for different cottons are:

	Cylinder	Doffer	Flats
Indian ..	100's	110's	110's
American ..	110's	120's	120's
Egyptian ..	120's	130's	130's
Sea Island ..	120's	130's	130's

The licker-in is generally covered with metallic saw tooth covering, and has about eight teeth per inch in width and four teeth per inch circumferentially.

Grinding of Cards

To ensure good work from carding engines the card-wire must be kept sharp. This is done by grinding the

card-wire with revolving rollers covered with emery cloth. The rollers are made to have a lateral traverse, so as to grind the side as well as the top of the wire. Grinding each card once per fortnight for several hours should keep the wire in good condition.

Stripping-out of Cards

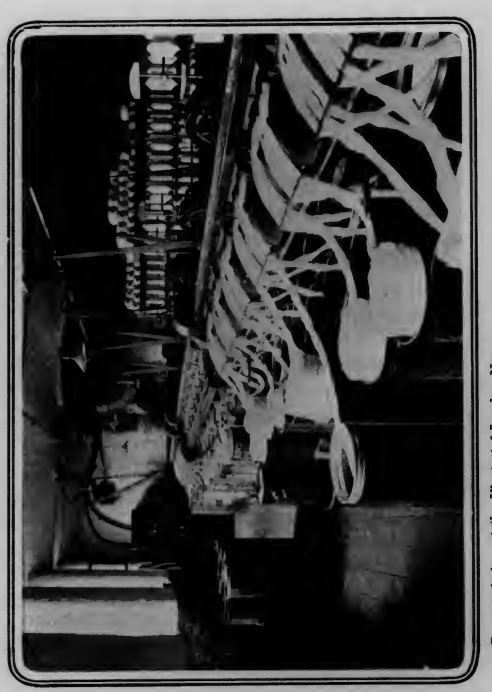
If the yarn has to be clean, the dirt collected by the cylinder and doffer should be periodically stripped out. The number of times depends upon the kind of cotton used and the quality of yarn desired. Generally speaking, for American cotton they strip out twice per day and for Egyptian cotton three or four times per day.

The stripping-out is done by placing a wire brush in bearings close to the cylinder and doffer, so that the long slender wire of the brush enters the cylinder and doffer wire about $\frac{1}{8}$ inch deep. The brush is revolved at a high speed by a rope and pulley, and it clears all the impurities from the wire. The brush is afterwards stripped out by hand.

There are many other details as to carding, on the efficiency of which the success or non-success of a mill may depend so far as yarn production is concerned, but those described are the principal and illustrate fully the carding system.

Drawing Frame

The slivers from the card are now taken to the Drawing Frames, the object being to minimise the irregularities in the sliver by doubling a number of slivers together, and drawing them down to the same weight per yard as any individual sliver coming from the card. The action of the draft rollers, too, has the effect of making parallel and polishing the fibres in the sliver. This gives a very



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FRAME ROOM

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FRAME ROOM

bright appearance to the sliver at the finished head of the draw frame. There are several reasons for the irregularity of the slivers. For instance, laps from the scutcher, fed to the cards, are far from being perfectly even. Then there is bad piecing of the lap at the back of the card, and it is generally known that after stripping-out the sliver runs fine for some time. To minimise the latter irregularity, the card is allowed to run a short time after stripping out, before piecing the sliver up.

There are two different arrangements of Drawing Frames, viz., the zig-zag and tandem. The former is very seldom used except in narrow mills. The latter is the generally accepted type because it is more convenient and is easy to work. The slivers at the draw frame, proceed through them, or form passages, according to the amount of doubling the cotton will bear, and the yarn requires. American cotton is generally put through three passages, with six slivers doubled together at each passage. This means 216 of a doubling. Egyptian and Sea Island cotton are generally put through four passages with six ends up. This would give 1,296 of a doubling. Some people double eight ends up for the finer cottons instead of six, at the draw frame, but six ends up and four passages is the most common practice for good cotton.

Let us now see the passage of the sliver through the Drawing Frame. One end of the sliver is lifted out of the can, passed through a sliver-guide to prevent the doubled part of the sliver passing forward, then over a spoon lever, which forms part of a stop motion ; then over a sliver traverse guide, and through four lines of top and bottom draft rollers, which draw the slivers about six times finer. The draft in the four lines of rollers is differentiated. The first pair of draft rollers

the cotton comes to has the smallest draft and each succeeding pair increases in draft. These draft rollers, both top and bottom, have clearers to keep the rollers clean. From the front draft roller it passes down to the funnel and calender rollers and drops down the inclined tube wheel into the can, which coils the sliver in the same manner as was described when dealing with the card.

Stop Motions

On all Draw Frames it is absolutely essential to have a good stop motion. In case any one of the six slivers at the back breaks, or a can runs empty, it is necessary that the frame should automatically stop or there would be five ends running instead of six, which would destroy the purpose of the machine. When a sliver breaks between the front draft rollers, and calender rollers, the machine must stop, or there would be a very large percentage of waste. Also when a can gets full the machine must stop or the coiler brackets may be broken. There are two different types of stop motions, one mechanical, the other electric. Both these stop motions provide for stopping the frame automatically, and both are largely used.

Weighting of Rollers

In order to get proper drawing it is necessary to weight the Draw Frame rollers. There are several different methods of weighting

It is necessary, if good work is desired, to have good top and bottom clearers. More experiments have been made in regard to clearers on the Drawing Frame than on any other machine. The clearer mostly adopted at the present day is the " Hermon," which consists of an endless piece of cloth stretched over two rollers made to

revolve on the top of the leather rollers. An oscillating comb with very fine teeth rests upon the cloth and receiving a reciprocating motion from the rocking shaft, the comb keeps the clearer clean and the accumulated dirt is picked off by the tenter.

There are also clearers under the bottom rollers to keep the fluted roller clean. These clearers are also picked by hand several times a day.

Drawings

Some years ago there were introduced metallic top-drawing rollers for Draw Frames and Fly Frames. These rollers have had a fairly wide adoption for the Draw Frames in many of the mills that have been built recently, but very few have been put to work on the Fly Frames. The object of these metallic top drawing rollers is to save the cost and labour in putting cloths and leather upon these top-rollers. These rollers need much lighter weights than leather-covered rollers. The production for the same diameter and speed of front roller as a leather-covered roller is much greater, owing to the extra length got by the meshing of the flutes.

Fly Frames

The Slubbing, Intermediate, Roving and Jack Frames are known by the names of Fly Frames or Speed Frames. All depends upon the degree of coarseness or fineness required as to how many of these frames the cotton is passed through. For very coarse hanks there would only be the slubbing and roving. For medium hanks there would be slubbing, intermediate and roving; and for very fine hanks, slubbing, intermediate, roving and jack. The object of all these machines is the same; that

is, to draw the material finer, twist it just sufficiently to unwind at the next process without breaking, and wind the material in bobbin form so as to make it convenient for handling at the next process. The only difference in these frames is that the slubbing, being supplied with sliver cans from the draw frame, needs no creel, and, as the hanks go finer, the gauge of the spindle rollers and lift and other parts of the machines need not be so great. These machines are driven by a belt from the line shaft, driving what is called the twist shaft. From this twist shaft every other part of the frame receives its motion. A wheel fast on this shaft drives the spindle shaft by a large carrier wheel, and fastened on the spindle shaft are skew bevel wheels driving the spindles. The twist wheel also screwed fast to this shaft drives the top cone drum shaft and front draft roller. The second and third draft rollers are driven from the front by gearing. The bottom cone drum which gives the excess speed to the bobbin and drives the lifter rail gets its motion from the top cone drum by a belt. The gearing of the driving to the spindles and bobbins is such that when the bottom cone drum is stopped the spindles and bobbins run at the same speed. It is this arrangement of speeds that enables the ends to run slack for doffing purposes. The variable excess speed required for the bobbin to wind the material on is given to it by the revolution of the bottom cone drum. Variable speed is given to the bobbin rail, which is necessary to keep the coils of rovings equally laid.

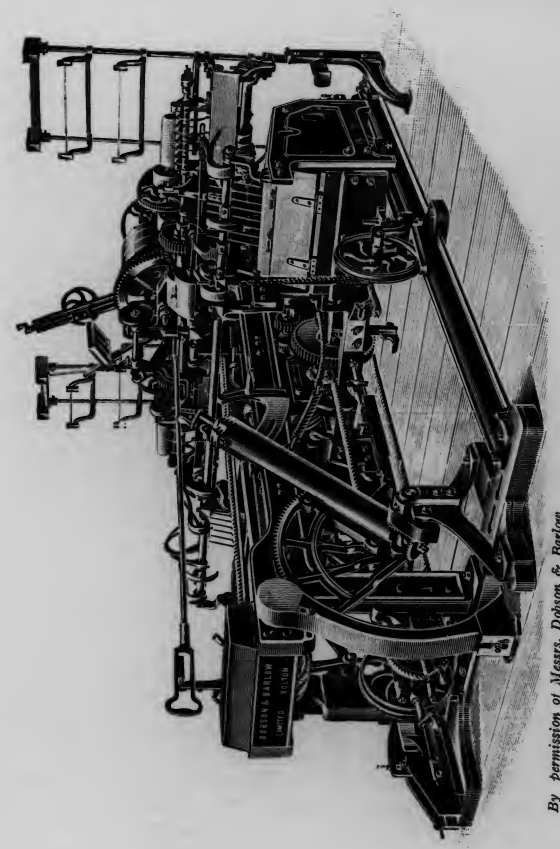
Doublings at the Fly Frame

There is never doubling of ends at the Slubbing Frame because of the great difficulty in dealing with double the number of cans at the back of the machine. At the

Intermediate, Roving, and Jack Frames, two bobbins are doubled to one end, to minimise the irregularity at the slubbing. We have the creels arranged at the next processes, so that it makes it very convenient to double. There are always single boss rollers at the Slubbing, but there may be single or double boss rollers at the Intermediate Roving and Jack Frames. Single boss rollers tend to better work. The advantage in using the double boss is that there is only required one half the number of rollers, weights and weight hooks, and consequently less work in scouring and cleaning.

Standard Twist put in the Material at these Frames

It is impossible to give arbitrary rules for twisting the material at the Fly Frames, because the twist has to be varied to suit the character of the cotton and the working condition of the frame. Although the hank being made may be the same, what is done in these frames is to put as little twist in as possible, so long as the sliver pulls the bobbin round at the next process without breaking. If more twist is put in than is required the production of the frame will be reduced, the leather top roller will wear out sooner, and the drawing will be more irregular. That part of the Fly Frame which supports and carries the bobbin is called the collar. There are two different kinds used—long and short. There are two systems of winding the rove on the bobbins at these Fly Frames, namely, Bobbin-to-lead and Flyer-to-lead. The latter system is now almost obsolete ; the former is becoming general. The cone drums on the Fly Frames, as well as the Scutchers, have to be concave and convex in form to give correct winding and feeding.



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SELF-ACTING MULE

Spinning Machines

There are three different types of spinning machines, viz., the Flyer Throstle, Ring Frame, and Mule. The object of all three is the same—to reduce the rovings to the required fineness or counts, to give them an amount of twist, which depends upon the kind of yarn being made, and the purpose for which it is intended; also to wind the yarn upon a double-flanged bobbin on the Throstle frame, and on a bobbin without flanges if spun on a Ring frame, and on the bare spindle on short thin paper tubes if spun on the Mules. All these machines have three lines of top and bottom rollers, the bottom line steel-fluted and the front top line covered with cloth and leather, whilst the middle and top back rollers are generally highly polished, self-weighted rollers, without leather covering. Spinning machines generally have about 1·2 of a draft between the back and middle lines of rollers and from five to eight of a draft between the front and middle line. The latter is the break draft, and depends upon the counts and quality of yarn required.

Flyer Throstle Frame

The Flyer Throstle Frame is used exclusively for twist yarns up to about 40's. Yarn spun on this machine is known and sold as " water twist " from the fact that the first machine was driven by a water-wheel. To spin yarn on the Flyer Throstle Frame a good class of cotton is required for the counts being spun, with plenty of twist, in order to pull the bobbin round in the spinning process. The method of winding the yarn on, in this machine, is the same as in the Flyer-to-lead principle in Fly Frames, with the exception that when an end breaks the bobbin stops, whereas in a Fly Frame it keeps on running. Yarn spun on these machines has a good

reputation; in fact, it is impossible to spin a poor, soft, weak yarn on these frames. Every inch of yarn is tested in strength on these machines by the yarn having to pull the bobbin round at about 5,000 revolutions per minute.

The Flyer Throstle Frame consists of a creel, sometimes a flat table creel and sometimes a vertical one, in which the roving bobbins are placed. The rovings are passed over guide rods and then through traverse guides and onwards to three lines of top and bottom drawing rollers to draw the material to the required fineness. When it emerges from the front draft roller it is passed down to a flyer which is screwed upon a spindle. The flyer twists the yarn and winds it on the bobbin.

Ring Frames

Comparing the three different systems of spinning, it may be said that the spindle speed in a Flyer Throstle Frame is only about 5,000 revolutions per minute. It takes more power for the same number of spindles, and there are fewer spindles in the same space as compared with a ring frame. It takes more time for doffing and more oil per spindle. The Ring Frame spindle revolves in a bath of oil that will last without re-oiling for a number of weeks.

The Ring Frame spindles run at from 8,000 to 10,000 revolutions per minute, thereby giving a much greater production than the Flyer Throstle. The Ring Frame is a continuous spinner, the twisting and the winding go on simultaneously. The Mule is an intermittent spinner. It draws the roving and twists the yarn as the carriage comes out, but the winding on is done when the Mule is running in to the roller beam. The Ring Frame is a much simpler machine than a Mule.

The Mule can spin a softer yarn than the Ring Frame, and upon the bare spindle.

The Ring Frame has made very rapid progress of recent years, both in this country and on the Continent, for the spinning of twist yarn up to about 60's and weft up to about 30's. The great defect in this machine is that the yarn has to be spun on a small bobbin or long thick paper tube. This prevents the yarn being used except on the premises where the yarn is spun, because it is too costly in carriage on broken bobbins, if the bobbins are returned. New mills that have part Mule and part Ring Frames have a reeling, winding and warping department, so that the yarns may be sent away in bundles or on back beams. In some cases manufacturers have thrown out their winding and warping frames and filled up this space with new looms, having found it to be more profitable to buy the yarn in back beam form and so increase their production by more looms.

The Ring Frame may be driven by a belt or rope from the line shaft. This drives the tin roller which in turn drives the spindles by a spindle band. Fixed upon the tin roller shaft is a compound wheel which drives through a train of wheels the cam which gives motion to the ring rail and shapes the yarn wound on the bobbin, and it also drives the middle and back draft rollers. The cam is so made as to cause the downward movement to be accomplished in one half the time of the upward movement of the bobbin rail. This is designed to give a binding thread to the body of the yarn, which causes the yarn to come off more freely when unwinding.

The traveller of the Ring Frame which varies in weight according to the counts of yarn being spun, clips the ring and revolves one revolution every time the spindles

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RING SPINNING FRAME, DRIVEN BY MOTOR

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The traveller of the Ring Frame which varies in weight according to the counts of yarn being spun, clips the ring and revolves one revolution every time the spindles

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RING SPINNING FRAME, DRIVEN BY MOTOR

make a revolution minus the retardation necessary for winding the yarn on the bobbin. The ring also varies in diameter according to the counts being spun. The finer the counts the less the diameter of the ring. The lift is also less for finer counts. The traveller puts the twist in the yarn as well as winding it on the bobbin by running slightly slower than the spindle. The yarn is wound on the bobbin after the style of building a cop at the Mule. On the rings' rail of the Ring Frame there are small pieces of wire with sharp edges set close to the path of the traveller when revolving round the ring. The object is to clean off the fibres and fluff that accumulate on the traveller and thereby improve the spinning.

Separators

The object of Separators, or pieces of plate projecting between the bobbins, is to reduce the amount of ballooning in the yarn caused by the revolution of the bobbin and traveller giving a centrifugal force to the yarn. The great defect in a Ring Spinning Frame and the one which has prevented its superseding the Mule to any large extent, is the fact that this machine cannot spin yarn commercially upon the bare spindle. Many experiments are now being made to secure this.

The Mule

The object of the Mule is to draw the rovings into the required fineness, to twist the yarn to give it strength, and to wind on a short paper tube or on the bare spindle as may be required. In this machine there can be spun a softer yarn, from a worse class of cotton than the Throstle or Ring Frame because the machine handles the yarn more gently. Another feature of some importance is that in the Throstle or Ring Frame the yarn is wound on as it leaves the front draft rollers, but on

the Mule the yarn can be made more level after it has left the front draft roller.

The modern Mule is much longer than Mules put in forty years ago, when a Twist Mule was about 750 spindles long and a Weft Mule 900 spindles long. To-day Twist Mules are made to contain about 1,100 spindles with a gauge of $1\frac{3}{8}$ inch, and Weft Mules have now about 1,300 spindles of $1\frac{1}{8}$ inch gauge. A full-size twist cop spinning 60's twist would be about $7\frac{1}{2}$ inches long and $1\frac{1}{4}$ inches diameter. A weft cop would be $4\frac{3}{4}$ inches long and $\frac{3}{4}$ inch diameter spinning 80's. The finer the counts spun the shorter and less diameter will be the cop. The stretch of a Mule (that is, the distance the spindle point moves outwards each draw) varies according to the counts spun. The finer the counts, the less the stretch. For about 30's to 60's there is a 64 inches stretch and for finer counts as low as a 58 inches stretch. The larger the stretch the more is reduced the piecing capacity of the spinner, besides getting worse spinning. As large a stretch as is consistent with good spinning and management must be secured or the production is reduced. In many mills the draft rollers revolve during the time the carriage is running in, with a view to increasing the length of yarn delivered per draw by about 3 inches. This is equal to having a 3 inches longer stretch so far as production is concerned but without the disadvantage of a long stretch. The spindles in a mule carriage do not stand up vertically but the points are inclined towards the roller beam. This is what is called bevel. In finer counts there is required more bevel than coarse counts. It is advisable to have as much bevel in the spindle as possible, so long as the yarn does not slip off the spindle blade during spinning, causing snarls. Snarls are loops in the thread and are very objectionable to the manufacturer.

There are many causes of bad spinning at the Mule, such as cotton not being good enough for the counts spun, slattered or uneven bobbins, or want of twist in roving, too big a draft in Mule rollers, too much gain and drag, knocking out too tightly, etc. There are quite a number of extra motions about a modern spinning Mule, especially if it is intended for fine counts. The temperature and humidity of the spinning require to be nicely adjusted if the best spinning is to be got from the cotton used. About the best temperature for a Mule room spinning American cotton is 78°, with the wet bulb standing at 66°. This is equal to six grains of water to a cubic foot of air. The high temperature softens the waxy coating of the fibres, which, when in a cold state, are hard and congealed, interfering with good spinning. All new mills are fitted with humidifying and ventilating appliances. Not only do these appliances humidify the air, but they purify it from soot, thus keeping the cops clean. They also improve the health conditions of the workpeople.

In spinning the finer and better qualities of yarn there are several extra processes. The sliver in this case would be taken from the card, passed through one passage of the Draw Frames, to level the sliver up somewhat. The slivers are next taken to a sliver lap machine, which doubles a number of the slivers together and makes a lap about 10½ inches wide. The laps are taken to a ribbon lap machine, which draws them, then doubles them at the front of the machine, and makes a lap ready for the combs. The object of both these machines is to make a lap uniform and homogeneous yard per yard, so that the comber can perform its duties better. These ribbon laps are taken to the comber, which remove all fibres below a certain length, and cleans the cotton from the very fine impurities which cannot be got out in carding.

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MULE-SPINNING ROOM—ELECTRIC POWER

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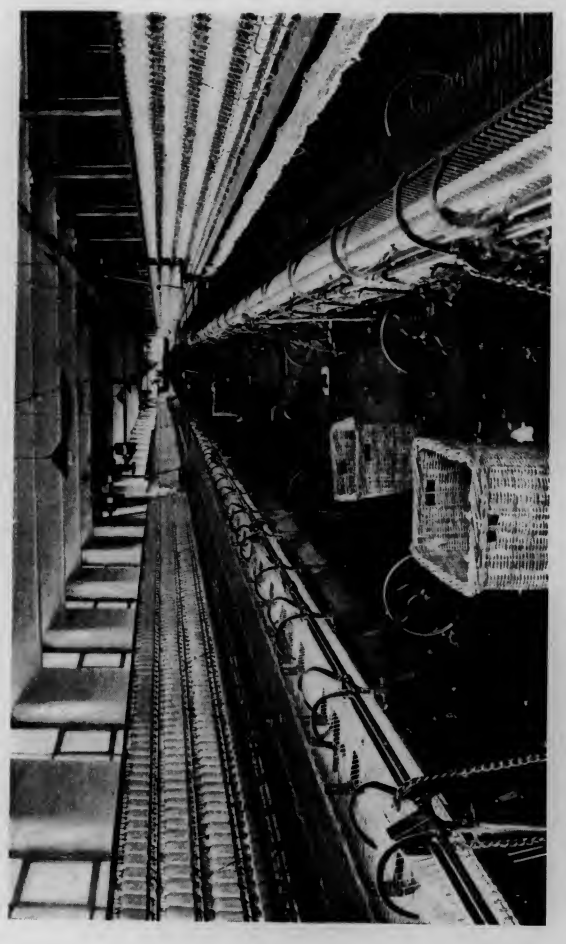

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MULE-SPINNING ROOM—ELECTRIC POWER

It is now becoming the practice to comb card strips. The old style of comber could only satisfactorily comb long fibre, but of recent years combers suitable for combing short-stapled cottons have been invented. These combers have encouraged many people to comb their card cylinder and flat strips, with very satisfactory results.

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WINDING FRAME

CHAPTER IV

WINDING, WARPING, AND WEAVING

THE cotton manufacturing industry of this kingdom, producing plain and artistic cloths in many varieties for all the Home Markets and Distributing Centres abroad, constitutes one of the great factors in our industrial and commercial greatness. Were we to seek for evidences of wonderful natural gifts and great genius, we can find them in an eminent degree in the evolution of the productive arts. One has only to compare the perfection of the system of cloth production in the present day with the primitive forms of olden times, to realise how wonderfully mind has conquered matter, and how cleverly it has brought scientific exactitude and artistic merit to bear in all the minutiæ of textile work. The Weaving Districts of England are principally centred in North and North-east Lancashire, where the humid climate is an advantage of inestimable value to cloth production. There is also weaving in the Bolton, Manchester, Ashton-under-Lyne, Stockport and other South Lancashire Districts, principally attached in the latter places to the spinning mills. In towns like Preston, Blackburn and Darwen, too, many firms both spin and manufacture. In Yorkshire there is cotton weaving in the district of Todmorden; and in the Scotch counties of Ayr, Renfrew, and Lanark weaving has in recent years increased in substantial measure. From the domestic production of spinning and weaving, there emerged the factory system. In describing the process of cotton manufacture we begin

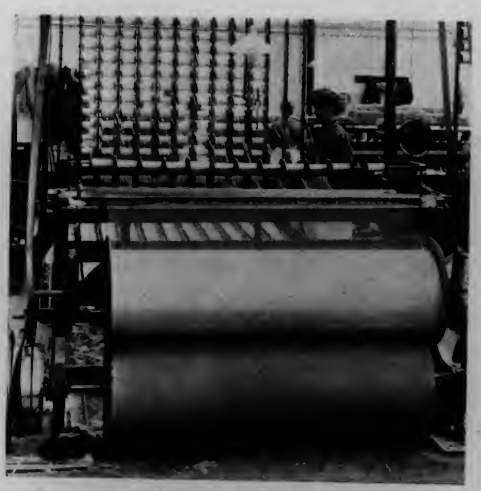
with the yarn as purchased from the cotton spinner and delivered at the weaving sheds.

The manufacturing processes, pursued in the weaving sheds, consist (1) of winding from the cop to the bobbin, (2) of warping or beaming, (3) of sizing, (4) of looming, and (5) of weaving. The yarn, as it comes from the spinning mills, is of two distinct series of threads—twist and weft. The twist forms the thread which runs from end to end of the cloth, and is called the warp. The weft threads, called "picks" of weft, traverse from side to side to the selvedges (self edges) of the cloth, and are sometimes called "woof" or "filling." Twist yarn having to bear a greater strain in the course of manufacturing, is stronger than the weft. The first process, after spinning, is that of winding. The object of this is to place a suitable length of yarn on the spool or bobbin. This bobbin is usually made of wood about one inch in diameter with a flange at each end of about 4 inches diameter, the distance between the flanges being about 4½ inches. The weight of yarn which can be placed on one of these bobbins is approximately three-quarters of a pound. In yarn of average or medium thickness, the length would be about 27,000 yards. The operation of winding is simple, and has little or no effect upon the material which is being used. The work of the winder is light and is quickly learned by girls or women, who earn on the average about 16s. a week. The usual cop winding machine will have about 360 spindles with one bobbin upon each spindle and about 30 of these spindles constitute the work of one winder. The work of the winder consists in replenishing the yarn and piecing up broken threads. It is essential that in piecing the thread the knot should be neatly made and the ends broken off short. A very ingenious apparatus, called the Barber Knotter,

has been devised by an American inventor. This is a small machine strapped on to the hand of the winder. The broken threads are placed in position for the repair; a lever is moved by the thumb and the knot is instantly made and the ends clipped quite close. It is claimed that this enables the operative to attend to more spindles, and that the knot is neater and better made, which is a great advantage in the subsequent processes.

Warping

The second process is warping or beaming, and here we have three distinct methods which are made use of according to the kind of cloth which the manufacturer is about to make. The methods are termed Beam, Mill, and Section Warping. In beam warping a number of the bobbins which have been filled on the winding frame are placed in a creel or frame, the usual number ranging from 500 to 600. The threads from the bobbins are taken separately, passed through the machine and made fast to the warper's beam. This beam is of solid wood about 5 inches in diameter and 60 inches long with an iron flange upon each end of a diameter of 21 inches, or thereabouts. This beam rests upon a revolving cylinder of wood which imparts the motive power to the beam, and gradually draws round it the threads from the bobbins. The amount of yarn which one of these beams will hold is about 300 lb. and a common length in medium counts would be 500 threads each 20,000 yards long. The principal device in this machine is the automatic stop motion, bringing the machine to a stand the instant a thread breaks. The operation is simple. A piece of bent wire about 2 inches long in the form of the letter " U " inverted hangs upon each thread. This is technically termed the drop pin. Should the



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WINDING YARN OFF BOBBINS ON TO WARPER'S BEAMS

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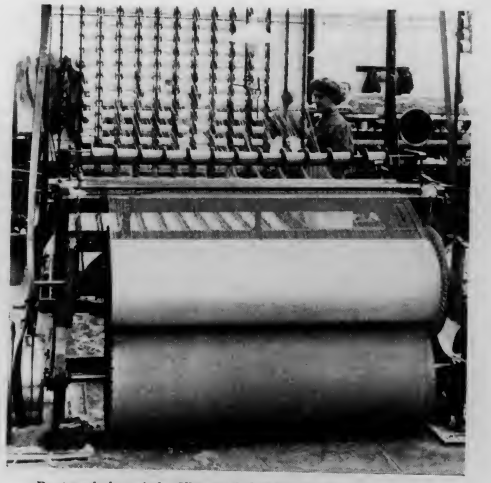

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WINDING YARN OFF BOBBINS ON TO WARPER'S BEAMS

thread break upon which the wire is suspended it falls down and is caught between two revolving rollers which are in close contact with each other. As the wire passes between these rollers it necessarily presses them an infinitesimal distance apart; but this distance though exceedingly small is sufficient to relieve a delicately adjusted lever which brings the machine to a stop immediately. The work of warping is genial employment for women; the wages earned are fairly good, amounting to about 22s. per week on the average. Usually the winders are promoted to the work of warping.

In mill warping the bobbins are also placed in a frame or creel, but the number is limited to about 200. The threads are then gathered separately from the bobbins and formed into a rope. This rope is made fast to a peg upon a large upright wooden cylinder or reel. The sizes of these cylinders or reels vary considerably but a common size would be one of 8 to 10 feet high, and 12 yards in circumference. This large cylinder is made to revolve in either direction, backwards or forwards, as required. After the rope of threads has been made fast to it the movement of the cylinder commences and as it revolves, the rope by suitable mechanism, is made to traverse from the bottom of the cylinder to the top, thus avoiding the whole of the yarn being run in one place on the cylinder. After the rope has got to the top of the machine, the direction in which the cylinder is running can, if required, be reversed and the rope begins to descend. By this means any suitable number of threads and length may be warped. For example, if a warp was required 360 threads, 500 yards long, 180 bobbins would be put into the creel, and 500 yards would be run on to the cylinder. Then the motion would be reversed, and similar ends and length would

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WINDING YARN OFF BOBBINS FOR WARP

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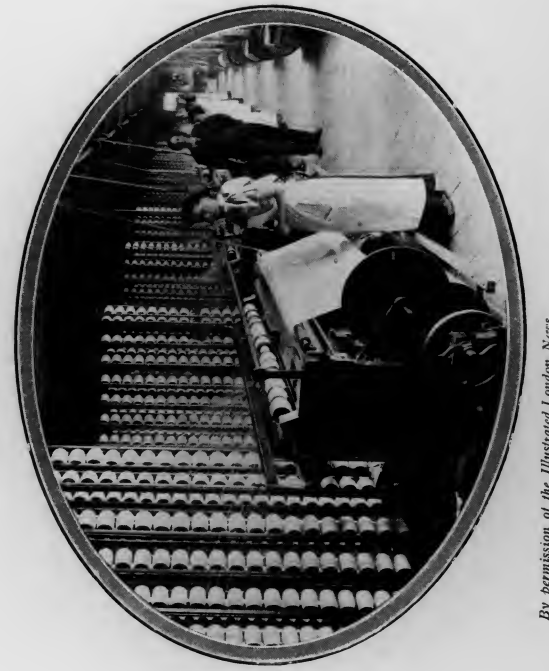

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WINDING YARN OFF BOBBINS FOR WARP

be run on to the top of the first, thus completing the warp required. This rope, or warp, as it is called, is then drawn from the machine and made into a ball for delivery to the dyer and sizer.

In the section warper the yarn used is such as has been previously sized, or yarn which does not require to be sized. These processes of sizing will be explained later. Here, again, bobbins are placed in a creel, and are drawn off on to a *cheese*. This cheese is a block of wood a few inches in diameter and length, and practically forms a miniature of the beam, explained in beam warping, but without the flanges. After a suitable length has been placed upon this cheese others of a similar character are formed. The whole of the cheeses are then placed upon a shaft and run off on to the weaver's beam. A cheese, therefore, really forms a transverse section of the weaver's beam. Where beam warping is used the cloth is usually made in the " grey " state, that is, it does not contain threads which have been dyed. If the manufacturer is one who makes coloured goods or cloth composed of coloured threads the mill, or section warping, will be the one which he will adopt. Manufacturers differ in their opinion as to the relative value of mill and section warping.

Sizing

The process following warping is that of sizing, which consists in applying a paste to the yarn in order to strengthen it and enable it to withstand the friction to which it is subjected in the loom, where there is considerable tension on the threads. For certain classes of goods sizing has additional uses, first to add weight to the cloth and, secondly, to give the cloth a " feel " or " handle " which enhances its market value. The necessity of sizing was realised in the old hand-loom

days when it was done in primitive fashion. The art of perfect sizing is obviously one of supreme importance. All twist which is single must necessarily be sized, but folded yarn will weave without size. A folded yarn is one in which two or more single threads are twisted together rope-like, the threads strengthening each other. This is the kind of yarn referred to in section warping, where it was stated that this peculiar process of warping was suitable for yarn which did not require sizing. The paste, or size, which is applied to the yarn, is in its simplest form made from some farinaceous substance such as wheaten flour, farina or potato starch, or sago flour. This is boiled in water, and a small quantity of tallow added to it, which keeps the yarn pliable. Japanese wax and paraffin wax are used as softeners in the light sizings, and castor oil and glycerine are at times used. The amount of size used varies according to the kind of cloth to be made. It may be as low as 5 or as high as 200 per cent. Those cloths holding above 50 per cent. of size are known as heavily sized, and those below that percentage vary from light sized up to about 20 per cent. and medium sized up to 50 per cent.

For cloths which require weight adding to them other materials are used, such as China clay, chloride of magnesium, muriate of zinc, etc., the latter being a great antiseptic and strong preventive of mildew. The prevention of mildew is of vital importance to the manufacturer, for if the vegetable growth is found to have developed, owing to sizing defects, after the cloth has reached the distributing centres, the loss falls on the maker. Size is mixed in strong wooden becks, equipped with revolving dashers, or agitators, which keep the mixture stirred up and ensures the blending of the various ingredients. The usual number of becks or tanks is four, each with pump attachment,

to send the size mixing, which has to be thoroughly boiled and with no granulation, on to the size box on the slasher frame.

The slasher may be divided into three portions, all coupled together, first, the sizing; secondly, the drying; and thirdly, the winding. Sometimes the process is called "taping," a term which was used in the days of the tape frame well on for half a century ago. A piece of cloth usually consists of several thousand threads, and in order to form these, a number of warper's beams of about 500 ends each are placed behind the sizing machine. The threads from each beam are then gathered together in one compact sheet and run under a roller which is immersed in the boiling size, which impregnates every inch of the fibre which passes into it. Mr. C. P. Brooks admirably illustrates this in his book on *Cotton Manufacturing*.

> "Supposing a warp is required of 2,480 ends—three beams, each 504, will be taken together with two of 484 each; these are placed in the creel in two levels, and the narrower ones are placed at the back. If they were in front of the broader ones the sheet of warp would overhang the narrow beams. The ends are gathered in one sheet, the layers from the hinder beams passing over the top beams and under the bottom ones, all leaving the creel after passing under the foremost beam and travelling into the sow box. Two contiguous boxes or troughs are used for holding the size—the one farther from the creel, called the size box, receiving the mixture directly from the beck, a regulating valve being fixed on the inlet pipe to prevent the box becoming too full. The sow box is the larger one, and receives the size from an aperture in the bottom of the size box, as

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A SIZING ROOM

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A SIZING ROOM

well as from a separate pipe. In the bottom of the sow box is fixed a boiling pipe of elliptical form, perforated with small holes, through which steam is forced into the size, causing it to boil, and thus always be in the fittest state for application to the yarn. At about half the height of the box two pairs of rollers are fixed, the back pair having the bottom one of wood, and the top one of iron, covered with flannel and cloth; the front bottom roller, or finisher, is of copper, having resting on it a heavy iron one, likewise covered with several layers of flannel and two of cotton cloth. On the firm and even surface of these rollers depends to a great extent, the quality of the sizing. Between the wooden roller and the end of the box nearest the creel is a copper immersion roller, its use being to lower or raise the warp in the size by means of a rack and pinion. The warp ends coming up from the beams pass under the immersion roller, thus being soaked under the surface of the boiling size, thence between the first and second pairs of rollers—the object of these being to press out all superfluous size and imbed into the thread that which is required. Immersing the thread deeply is advantageous for heavy sizing, although, by simply dipping it, the fluid only attaches itself to the outside of the thread. Better results could be obtained by pressing the yarn whilst under the surface. Unless well boiled, size retains a granular nature, causing faulty cloth; to obviate this, many machinists insert between the size beck and the sizing frame an extra boiling apparatus so arranged by the intervention of pipes to boil the size under pressure, impinging steam against the particles of size as they enter the box, thus breaking the globules. After boiling thus, the size enters the box in the ordinary way. To

lay the fibres on the yarn a few sizers have recourse to revolving brushes acting on the thread directly after passing the finisher roller. These revolve about 700 revolutions per minute, considerably faster than the warp speed. They are considered advisable for fine reeds and fancy goods."

After leaving the rollers the yarn passes over two steam-heated revolving cylinders, of about 7 feet and 4 feet diameter respectively, and is then wound on to the weaver's beam, in front of the machine. This process of sizing is applied to yarn made on the beam warper. To indicate the weaving lengths the warp is marked by the measuring roller on the sizing frame.

As stated in mill warping, the warp in that process is gathered up into a ball. This ball form is simply for the convenience of handling. The ball is taken to the sizer, is unwound, and the rope of yarn is passed through the boiling size, and is afterwards dried on hot cylinders, the threads spread out and run on to the weaver's beam. The differences between the two systems of sizing are known as tape-sizing and ball-sizing. The work of sizing is done by men who are well organised as a trade. They are in receipt of good wages, usually about two guineas or more per week.

Looming and Drawing

The beams holding sized warp, varying from 500 to 1,000 yards in length, are now taken into the Looming Loom, where the threads of the beam are attached to the healds and reed. The healds are for the purpose of raising the threads as required in the loom to form the pattern of the cloth. The reed may be described as a kind of grate or grid, the bars being made of extremely fine wire placed at suitable distances

apart in strips of wood, by the aid of machinery. The reed has a three-fold purpose—first, to give support for the shuttle as it passes from side to side of the loom; secondly, to keep the threads of the warp in their proper place in the cloth, and thirdly, to bring up each succeeding line of weft in close contact with the one which preceded it. The loomers and drawers who attach the beams to the healds receive about 30s. per week, and the work is of a light character.

Weaving

We have now reached the final stage by which the cotton is converted into a woven fabric—that of weaving. It will be seen how the textile processes are conducted in sequence, with the greatest expedition and economy of labour. The machinery in the various departments is driven by the powerful modern engine. It may be taken that a condensing horizontal engine of 250 indicated horse power will be required to drive 1,000 looms, the steam being generated in double-flued steel boilers where it not uncommonly attains a pressure of 120 lb. per square inch. The huge development of cotton manufacturing has been one of the industrial phenomena of the past 100 years. It was in 1801 that the first power loom weaving shed, holding about 200 looms, was built and worked on a successful basis. The great strength of British weaving, as pointed out, resides in North and North-east Lancashire. Here the majority of the sheds are owned by private firms, but a few are owned by companies formed under the Limited Liability Act, which was passed in 1862, and enabled working people to invest their money, with a limit to their liability. The plain loom is the foundation of all weaving; the fancies, etc., being developments in mechanism, some of an intricate character. Art has

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SIZING

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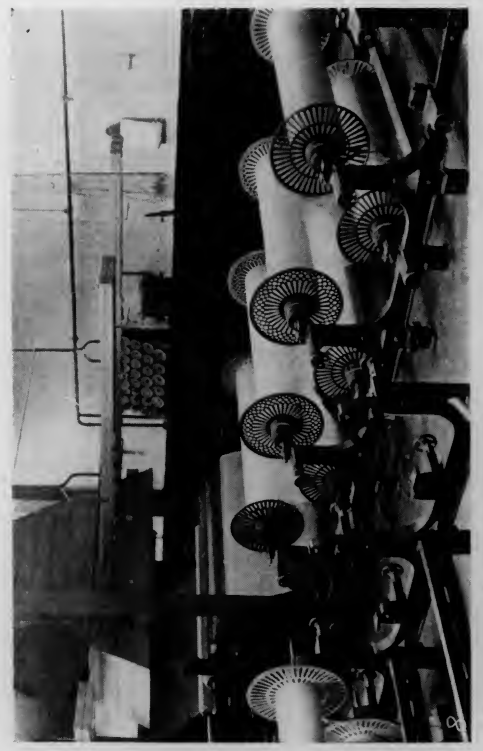

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become more and more the handmaiden of industry, as will be seen in the references to education in a later portion of this work. The width of cloth varies from about 20 inches to 100 inches, though even this is sometimes exceeded, the average width being about 42 inches. We have seen with the completion of the sizing how all is ready for the culminating process. The beam with the healds and reed is taken to the loom, the various parts being fixed in position on the framework. The warp (which is held taut and straight by the taking-up roller in front of the loom) passes over the back rest to the healds, between which are large and small lease rods, which divide the warp. The weft is skewered in the shuttle, driven by the picking stick from side to side and interwoven with the warp, cloth being rapidly made. The various forms of looms, and the appliances for making different patterns and qualities of cloth are innumerable, and would occupy of itself many volumes to adequately describe. Briefly put, weaving consists of three operations—first, to divide the warp by lifting up certain threads and leaving others down to form the desired interlacing of the warp and weft; secondly, to throw the shuttle between these two sets of threads, leaving a line of weft in its track; and thirdly, to bring this line of weft up to the one which has preceded it. These operations are technically termed "shedding," "picking," and "beating up." "Shedding" is done by three distinct sets of appliances termed tappets, dobbies, and Jacquards, which are limited to the formation of simple, medium and difficult designs. These are again subdivided into many kinds of each sort; each with its own peculiar advantage to some special make of cloth. Reference has been made to the growth of artistic treatment of cotton cloths. To give some idea of the various kinds of tappets

there are, among others, positive, negative, wood-croft, oscillating, etc. Some work outside the loom, some inside and some overhead. In dobbies there are single-lifts, double-lifts, open shed, centre-shed, and many more. In Jacquards there are single and double lifts, some described as single cylinder, others as double cylinder, all having their various peculiarities, advantages and disadvantages, where so many kinds of cloth are to be made. There are many kinds of picking motions, such as under-pick, over-pick, scroll-pick, each again particularly useful for different fabrics; but all serving the same purpose, namely, to throw the shuttle from side to side of the loom. The over-pick is the commonest. The shuttle is usually made from cornel or persimmon wood. It is about 13 inches in length with iron tips at each end. Inside the shuttle is an iron peg on which the cop is corkscrewed and the thread is drawn by the weaver by suction, through the eye of the shuttle.

The beating up is invariably formed in one way in all looms; that is, to carry the reed forward, with the line of weft in front of it, up to the edge of the cloth, which is being woven. The reed then recedes for some 5 inches for another pick of weft, which is beaten up, and so the weaving proceeds. The loom has also other minor appliances. There is one, for instance, for stopping the loom when the weft-thread breaks, or the supply of weft runs out of the shuttle. Another portion of the mechanism is for carrying the cloth forward on to a roller as it is woven. A third enables different kinds of weft to be automatically inserted in the cloth by means of shuttles (each of which contains a different kind of weft) being thrown across the loom in any required order.

The weaving shed is a most interesting sight, often

containing 1,000 looms, the rattle of the machinery being almost indescribable to a visitor, yet to the busy operative it is hardly realised. The shuttle in each loom often passes across the sley 200 times a minute, and a single loom will often weave 200 yards of cloth in one week. This, of course, varies considerably according to the kind of cloth which is being made. The art of weaving is one which requires considerable skill, the wages earned varying from 10s. to 30s. per week, according to the number of looms which the operative controls, and the class of goods which are being produced. The number of looms operated by one weaver varies from two to six, the average being three to four. The shed and the preparing departments are directed by a manager, who is a thoroughly experienced man, with great technical knowledge, and an economical administrator, who has to keep strict eye on the details of expenditure. The weavers are controlled by an overlooker, who is responsible for the work which is turned out by a section of the looms varying from 60 to 100, according to the class of cloth which is being made. The overlooker, or tackler, sees to loom repairs, to the looms being supplied with warps, correctly gaited, etc., and he has an interest in doing all he can to keep up the production and therefore also the earnings of the weavers.

As will be shown later, the plain and fancy cloths made in such infinite varieties are distributed throughout the world, our two greatest markets being India and China. The spread of the cotton trade throughout the world is most remarkable. For a long time Lancashire was practically the sole producer of cotton cloth, but now the manufacturing system is rapidly becoming adopted by all civilised countries. The competition, too, is extremely keen, and the utmost vigilance is

required if the manufacturer is to secure an adequate profit upon the capital invested.

The actual fabrics themselves are divided into five classes: plain, twill, figured, gauze, and double cloths. The ordinary calico is an example of PLAIN cloth. TWILLS are those where regularly defined lines run obliquely across the piece. FIGURING is applied to cloth with more or less elaborate designs, from the common spot to a large floral effect. GAUZE fabrics are cloths where the warp threads are made to cross each other instead of running straight. A common form of DOUBLE CLOTH is the woven bag, or pillow-case. Another class may be referred to, though it is really one of the foregoing. It is that of pile cloths, of which velvet is the common form. But in addition to all this, these various classes are subdivided into almost innumerable varieties of each class. Take, for instance, that of plain cloth. Amongst the varieties are shirtings, printers, jaconettes, long cloths, dhooties, madapollams, royal ribbs, poplins, etc.; all these being of a perfectly plain weave but differing in texture and appearance, and adapted for the peculiar requirements of people all over the world. India and China are the large markets for shirtings, but the Chinaman, as a rule, requires a better article than that which will find a purchaser in the Indian market. Dhooties are goods confined solely to the Indian trade. A plain dhooty is a plain calico with coloured edges varying from $\frac{1}{8}$ inch to 3 inches in width, and at regular distances of from 2 to 5 yards coloured bars of weft of a more or less elaborate character pass across the piece. These dhooties form an important article of clothing in India, the coloured portion being considered a phase of ornament. Borders are sometimes also worked up into more or less elaborate figures and they then pass from

the plain section to the figured class, necessitating the use of other appliances to the loom, such as the Dobby and Jacquard.

The texture of different classes of dhooties also varies to a very great extent. In some the yarn is of a very coarse kind and is heavily weighted with size ; in others the yarn is of the finest character, the difference between the two cloths, although for the same market, being very remarkable. Probably the requirements of the various classes, from the very poor to the better circumstanced, is the reason accounting for this. In some cases, the coloured borders, in addition to being elaborate in the way of figuring, are formed of coloured silk threads instead of cotton, thus increasing the value of the piece to a great extent. As nations become more civilised the requirements change from that of a common character to one embodying more or less elaborate detail and better finished articles, and to China and Japan there are now shipped large quantities of the very best class of figured goods. From the near Eastern markets quite different classes of fabrics find sale. We find crimps and crepons in large demand. These are goods which have a crimped or creased appearance on the surface. For the home trade the best qualities of plain goods as well as the more finished fabrics are in demand, and during recent years the production and sale of flannelettes has greatly increased. These various classes of fabrics are in some instances almost confined in their manufacture to certain districts being in a sense their specialities ; but as the spread of education and competition goes on the distribution is more widely spread, manufacturers being gradually forced into producing other classes of articles than those to which they have been accustomed.

Blackburn is probably the largest centre for the

making of shirtings, enormous quantities of these goods being turned out daily. A large section of the dhooty trade is also located in the same town, though one or two of the smaller places, such as Darwen and Great Harwood, seem principally adapted for this particular kind of fabric. In the Rossendale Valley the principal manufacture is of coarse goods which are very heavily sized. In Preston and the immediate neighbourhood the goods manufactured are generally of a most elaborate kind, though in the town itself there is probably the first firm of shirting makers in the world. In Bolton district the classes of goods made are chiefly fine cambrics, a great many quiltings, coloured counterpanes, etc.

In the making of velvets a large proportion of the weft threads are allowed to form to some extent loosely upon the surface of the cloth. Under these weft threads a fine knife is run, severing them, and causing the ends to stand upright which gives the peculiar surface which is associated with the velvet cloth. A large use is now being made of cotton to imitate woollen products. One of these is commonly known as flannelette. This is an ordinary cotton fabric made from coarse yarns. After being woven it is passed through a machine which combs up, or teases, the fibre on the surface giving it the peculiarly fluffy or woolly appearance which is so well known. The heavy pile cloths include corduroy, moleskins, cords, fustians, bull-hides, etc.

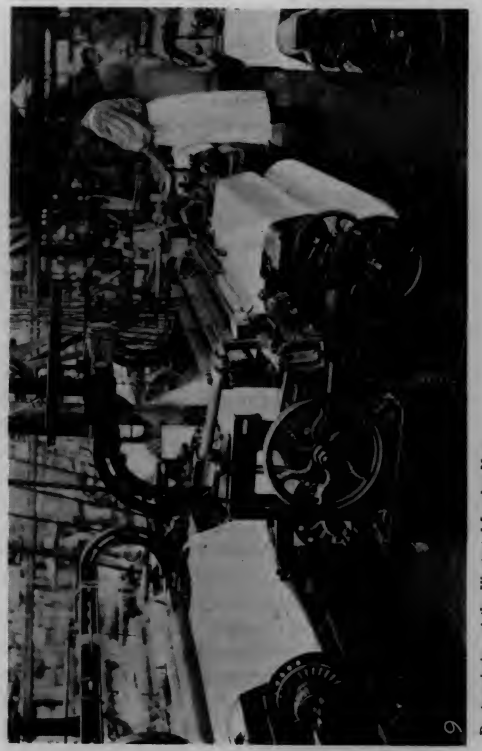
From the Weaving Shed the weaver takes her " cuts " or pieces of cloth to the warehouse, where they are received by the cut-booker, and her wages are made up from the list prices. The cloth is put on the folding machine which plaits it into yard folds. The cuts then go (marked with the loom number of the weaver) to the

cut-lookers, who stand at their benches and rapidly examine the cloth to discover any imperfections. For cloth faults due to the weaver, such as " floats " caused by failure to interweave at some point, the weaver is " bated " or fined according to the seriousness of the fault. Cracks in the cloth, uneven cloth, cockly cloth, bare cloth, mashes, broken picks, etc., are all noted, as well as any short lengths, wrong widths, wrong weights, incorrect headings, and come within the observing and classifying duties of the cloth-looker. The cloth headings consist of lines or bars of coloured weft at each end of the cloth or in other places. They are to distinguish the piece and to indicate where the pieces are to be separated. Some of these headings are very deep and attractive, with lines of gold thread and coloured weft.

In the cloth warehouse the cloth is made up into bundles. Some are sent directly to the shipper, others go to the Manchester warehouses, where they are again examined, whilst others go direct to the bleachers.

Technical Education

The great advancement in technical education has made, and will probably still further increase, the production of cloths of an artistic character. In the technical schools of Lancashire and other counties, in which cotton spinning and manufacturing is conducted, the textile classes are attended by large numbers of students, some of whom have obtained important managerial positions. There are thousands of students from the operatives' ranks who can bear testimony to the great advantages they have gained through the courses of instruction given in these institutions. Examinations are periodically held, and the prizes on a very liberal and attractive scale are given by Local



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WEAVING

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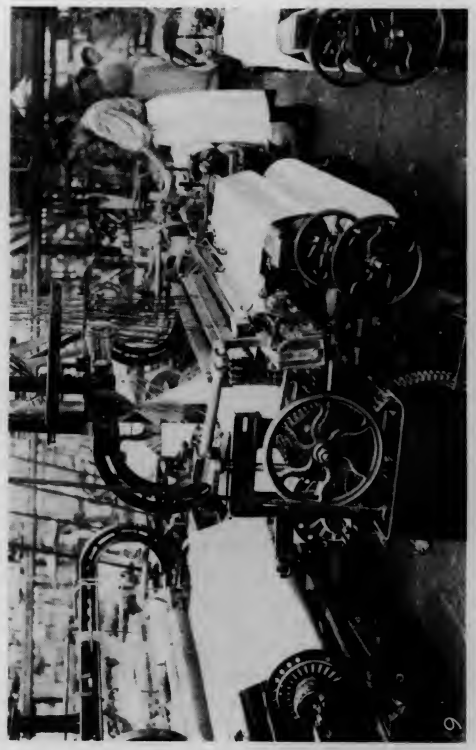

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Authorities, County Councils, the City and Guilds of London Institute, the Worshipful Company of Drapers, and other bodies. The instruction given is not merely theoretical. The latest machinery is set up in some of the institutes and the whole details of both the spinning and manufacturing processes are made manifest.

Automatic Looms

The intense competition in trade has had the effect of stimulating invention, of patenting appliances for making peculiar classes of goods, and for increasing the production of machinery. One of the most important of the latter kind is the Northrop loom, an English invention, bought by an American firm, which is largely in use in the United States and has been introduced into Lancashire. Seeing that the automatic principle will more and more come into use in the future, it will be of value and interest to look into a Rhode Island mill and see the loom at work. There are marked differences in the systems and organisations of English and American mills. A visit was made to the cotton spinning and weaving districts of America by a body of English manufacturers in 1902; they found the Americans were making greater headway than we in England in the economy of production. They found also that there had within the past quarter of a century been phenomenal developments in manufacturing in the Southern States, and that there was now a marked growth of their competitive power. In some of the sheds in the Southern States it was found that quite young children were largely engaged, which meant of course a large reduction in the wages bill as compared with the North. The goods in which this labour was chiefly employed upon was in sheetings, jeans, and drills for the distributing centres in China, and it was

obvious that the odds operated as heavily against the New England mills as they did against those of England. The American Trades Unions, however, are growing in strength and the tendency is yearly in the direction of equitable wages adjustment. It was found by the Lancashire commission that the American spinning mills did not get a great advantage over us, in the cost of carriage for the raw material. As a matter of fact, Mr. T. M. Young, who accompanied the English deputation and who wrote the results in a series of articles reproduced under the title, *The American Cotton Industry*, found that the cost of bringing raw cotton to the mills of New England was practically the same as that of conveying it to the Lancashire spinner. In South America some advantage is gained, but it is inconsiderable. The great difference between British and American manufacturing systems is the extensive use in the States of the automatic loom, affecting a marked reduction in the cost of production, yet materially advancing the wages of the weaver. These looms were adopted by Germany, France, Belgium, and Austria before they were introduced into Lancashire.

It was at a mill close to Fall River and within the State of Rhode Island that Mr. Young found 2,000 Northrop looms and 743 other looms all 32 inches wide or more, making twills and sateens largely from 28's to 36's weft, spun from " strict good middling " cotton of 1 inch to $1\frac{1}{8}$ inch staple. These looms were fed by 17,300 mule spindles and 60,000 ring spindles and the mill was driven by a steam engine of 2,000 indicated horse-power, the annual consumption of coal being about 8,000 tons, and the cost of coal was then about 13s. 6d. per ton. Seeing that this automatic loom is coming into great use, a description of it will be valuable, Mr. Young says:

"The essential difference between it and the common or any other automatic loom is that when the weft breaks or is exhausted, the shuttle is automatically recharged with weft, and threaded without being itself removed from the sley. There is a cylindrical battery or magazine, like a magazine of a revolver, over the shuttle box at the side of the loom, and this magazine can be filled with 'cartridges'—either bobbins of ring weft or cops of mule weft. Ring weft for the Northrop loom is spun on specially made bobbins, which are simply laid into the magazines; cops have to be skewered upon a steel spindle, with a wooden head similar to that of the ring bobbin. When the weft-changing mechanism is brought into play by the action of the weft-fork, a bobbin, or a cop on its skewer, is forced from the magazine into the shuttle, which is always then at the end of the sley immediately beneath the magazine; the spent bobbin, or skewered cop, is forced out through the shuttle and the bottom of the sley, and with the first impulse of the picking-stick, the shuttle threads itself and the weaving continues without interruption. All that the weaver has to do, then, in regard to the weft, is to keep the magazine charged with weft, and as there is always a contrivance in these looms which stops them when a warp thread breaks, the weaver has no need to watch the warps; when he sees the loom standing, he goes and finds the broken end and ties it up and starts the loom again—that is all. The weft magazine may contain as many as thirty charges, enough to keep the loom running for a couple of hours. The Northrop loom is the invention of an Englishman, James Northrop, formerly of Keighley; but the Draper Company, of Hopedale, Massachusetts, who bought the patents have spent very large sums of money in perfecting the machine and adapting it to the varying exigencies of industrial use."

It is clear this loom will have to be largely adopted in Lancashire before long.

There are two things which have probably hindered the adoption of the Northrop loom in this country. First, its price, which is about four times that of our ordinary loom, and secondly, the natural resistance on the part of the operatives, who have now been organised for many years. Still, it is slowly and surely making progress and will continue to be gradually installed as the ordinary looms are worn out. Near Manchester there is at the present time a shed holding 1,000 looms, all properly laid out and equipped.

CHAPTER V

BLEACHING, PRINTING, AND DYEING

THE printing and dyeing of cotton fabrics is something more than a mere mechanical operation. The development of this branch of industry is due to the skill of the cleverest chemists, foremost amongst these being John Mercer, the inventor of the mercerising process by which cotton cloth is made to resemble silk, and the late Frederick Steiner, a famous French chemist, who introduced a turkey-red dye, famous all over the world.

Before it can be dyed or printed upon, all cotton fabric must be bleached, to rid it of all impurities or everything present in the fibre except cellulose—or, in other words, a small quantity of margaric acid, pectic acid, albuminous matter, and colouring substance. In woven goods the artificial impurities may amount to 20 or 30 per cent. They consist of grease, starch and other ingredients used in sizing, besides oil from the machinery. The removal of these impurities in order that nothing but pure white vegetable fibre may remain is the result sought with the highest grade of bleaching —technically known as the " madder bleach "—because it was first applied to goods to be printed with madder, a substance much used in dyeing red. It is also used for cloths which are to receive light and fine colours.

Previous to the bleaching operation proper, the pieces are singed, in order that the fine loose down may be burned off the surface of the cloth, as this down interferes with the production of a fine impression in the printing process. This operation is performed by rapidly passing cloth in the open width over red-hot copper plates or

between rows of Bunsen burners, while the cloth is drawn rapidly over one or more of these hot plates by means of rollers ; a frame with iron bars depresses the cloth tightly upon the hot plate. After passing over the singeing plate or between the gas burners, the cloth is immediately passed through a water trough, or through a pair of wet draw bowls in order that any sparks may at once be extinguished. The pieces are drawn direct from the singeing house, guided by means of glazed earthenware rings through the washing machine and plaited down " in pile " on a stillage in the bleach house, where they are allowed to lie a few hours to soften. The second process in bleaching consists in boiling the cloth in milk of lime and is a very important one. As already stated, the cotton fibre is made up of cellulose and a small quantity of other substances. The object of the lime boil, therefore, is to break up the combination of the wax and cellulose. The selection of lime is also a very important matter, as if the lime be old it will have absorbed carbonic acid from the atmosphere, and this will render it unfit for bleaching purposes. Having been boiled in lime for about twelve hours, the cloth is passed on into the kier. The cloth must be packed in the kier very systematically, this being done by boys, who go into the kiers when they are being filled, and with their hands and wooden clogs on their feet carefully tread down the cloth in such a way that it will not get tangled in the boiling process. After the goods have been properly boiled the waste liquor is run off from the bottom of the kier and the cloth is drawn by the draw bowls of the washing machine from the kier. At the same time much of the lime and dirt is removed from the cloth during its passage through the washing machine, but as only a portion of the lime can be removed in this way, the cloth is next subjected to a

treatment with weak hydrochloric or sulphuric acid. The next operation is boiling the cloth with caustic soda. After the cloth has received another washing and passed through a weak solution of chloride of lime and dilute hydrochloric or sulphuric acid, it is ready for being printed upon.

Until the invention of machinery, the operation of printing was performed entirely by hand. The design was applied by means of blocks of some hard, fine-grained wood, such as pear or sycamore. Upon the face of the block the design is carved much in the same manner as a wood engraving. Sometimes the pattern is formed by slips of flattened copper wire inserted along its outlines, which are first traced upon the wood. The copper slips are carefully bent to the required shape and are then forced into the positions they are to occupy by gentle hammering. The upper edges where the copper stands above the wood are levelled with a file, in order to form one even surface, and polished. The spaces between these slips are filled up within the boundaries of the design with pieces of thin felt. In hand-block printing, the piece to be operated upon is spread out evenly upon the printing table, which is covered with blanketing. Close to the printer stands a tube containing the colour. A wooden drum, like the wood work of a sieve, is covered with waterproof tissue, over which is stretched a fine woollen cloth, upon which the colour is spread. This drum is placed so as to float on the tubful of old paste.

The colour is spread on the drum-head. Then the printer applies the face of the block to the drum-head, then lays it carefully upon the cloth and strikes it on the back with a hammer or presses heavily upon it, so as to force the colour into the cloth. The great drawback to this method of printing is the expenditure

of time and labour involved. To print a piece of calico of the ordinary length, 28 yards by 2 feet 6 inches, with the ordinary size blocks requires about 672 carefully managed applications. If there are four or five colours the number of applications are from 2,600 to 3,300. To a very large extent, therefore, block printing has been superseded by machine printing. The machines now in use can print designs embodying as many as twenty different colours, and the largest machines can turn out anything up to 500 yards of cloth per hour. The design is first engraved on copper rollers. If there are several colours to be printed, each colour has to have a separate roller, and it is the duty of the man in charge of the machine to see that all the designs are so fitted that they will form a perfect whole. The machine consists of a large iron bowl, or drum, against which are pressed the engraved copper cylinders, the colour being supplied to the cylinders by wooden rollers covered with cloth, or sometimes by cylindrical brushes, called "furnishers." The furnishers revolve in the colour, which is contained in long troughs called "colour boxes." But as the furnishers supply the whole surface of the engraved cylinders with colour, as well as the engraved parts, the surface colour has to be scraped off again, and this is done by means of a steel blade, known as the "colour doctor." The cloth to be printed passes part way round the bowl of the machine and between the engraved rollers and the bowl, when it receives the colour. In order to remove any lose threads or filaments from the roller, a "lint doctor" is used, working on the opposite side of the engraved roller to which the colour doctor is applied. The doctors are made of well-tempered steel, and they have to be exceptionally sharp in order to effectually remove the surplus colour without doing injury to the engraved copper roller. The machine printer has many

difficult duties to perform. Besides tuning up the doctor and keeping the pattern rollers in register or fit, he must carefully adjust the amount of pressure, so as to bring out the print and yet not press the colour too far through the cloth.

After being printed, the next operation is drying, this being of great importance. The methods of drying vary. In some cases, copper or tinned iron cylinders, heated by steam, are used for the purpose and in others flat hollow cast-iron boxes, called steam chests, over which the cloth passes without quite touching. It is necessary to state, however, that after bleaching and before printing the cloth is prepared with oleine oil.

In the preparation of colour each works has a staff of chemists who are constantly experimenting with a view to securing more brilliant or faster colours. The majority of colours are derived from coal-tar. The two mordants, red and black liquor, are very largely used by calico printers in what is called the dyed or madder style, one of the oldest and most important of the various styles of calico printing. In this style the thickened mordants are first printed on, then dried, aged, dunged, and dyed with alizarine, or other acid colouring matter. Before they can be printed, mordants have first to be made into what are technically called "colours." In other words, they have to be made into a kind of paste by means of some thickening matter, as starch, gum, etc. These colours are not necessarily coloured substances, though they do usually contain some kind of colouring. This, however, is only for the purpose of sightening, so that the printer may be able to see his work on the cloth. This sightening is afterwards washed out of the cloth. Prior to being dyed, the cloth must pass through the ageing and dunging, or fixing, processes. The object of the former is to decompose the acetates, so that the

acetic acid is driven off, leaving the insoluble bases on the fibre. Steam machines are used for this process. After passing through the machine, the cloth is folded up in loose bundles and left for twenty-four hours. The decomposition of the mordants, which was started by the action of the steam in the ageing machine, goes on slowly whilst the cloth lies in the bundles. As this ageing does not effect a complete precipitation of a suitable mordant on the fibre, it must be followed by the fixing process. Then follows the dyeing. After dyeing, the cloth is well washed in cold water, and afterwards dried. In the extract style of printing, the mordants and colouring matters are mixed together and printed on the cloth in one operation, after which they are steamed. With the extensive use of the many-colour printing machines, the extract style has become more prominent, and it gives far more beautiful effects of colouring. Colours for the extract style are printed on cloth previously prepared with oleine oil. By this means faster and brighter shades are produced.

The shades of colour in which the cotton fibre is dyed and printed are almost innumerable, but they are almost all made up of red, yellow, blue, black, and white substances. To obtain the shades, the various colours have to be boiled, but it does not follow that all shades are boiled. If a very dark shade is prepared it is a very easy matter to obtain a lighter shade by reducing it. This, in brief, is an outline of the bleaching, printing, and dyeing processes.

CHAPTER VI

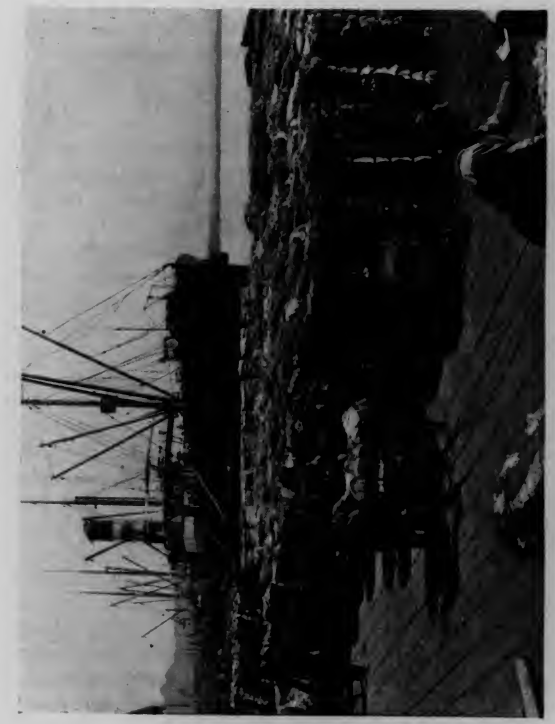
MARKET DISTRIBUTION OF YARN AND CLOTH

WHILST Liverpool is the great market for cotton, a considerable quantity of the raw material comes direct to Manchester, via the new Ship Canal, the cost of transit being much cheaper for the cotton mills in the Manchester district. The great central emporium for the sale of both yarn and cloth is the Manchester Exchange. Manchester is the Mecca of all connected with the English cotton manufacturing business. At the end of the eighteenth century the master attended the weekly market at Manchester and sold his pieces in the grey to the merchant, who afterwards dyed and finished them. At times goods were sold outright to the calico printers. Deliveries of prints would be made at the Manchester warehouse from the print works on Tuesdays, Thursdays, and Saturdays in the busy season of spring and autumn, and the pieces would be sold to the drapers who flocked to the warehouses. At one time the merchant or his representative rode over the country showing their patterns to the mercers, and the cloths were afterwards forwarded over the roads by the waggons of the carriers. The foreign trade was at the outset—some 240 years ago—founded by British merchants or their agents who travelled, but it was not very long before the representatives or members of foreign firms came and settled themselves in Manchester, and from that day to this they have steadily increased in number. At the present time great commercial houses from almost all the nations of the world are directly represented on the boards of the

Manchester Exchange on market days. The Exchange presents the busiest aspects on Tuesdays and Fridays, the principal market days, when the floor is crowded with principals and agents—spinners, manufacturers, bleachers, dyers and printers, machine makers, and representatives of all firms having direct or indirect connections with the cotton industry. The capital represented is stupendous. Yarn and cloth agents are very numerous. The yarn agent finds the customer for the spinner from whom he receives his commission. Every firm is directly represented on the market and very many have their own Manchester warehouse and offices, some on a very large scale. Some of the most influential cotton spinning and manufacturing firms are merchants also, and send their travellers out to all the towns and cities of this kingdom and foreign nations. "The cloth market," says Chapman in his admirable work on *The Lancashire Cotton Industry*, "is far removed in character from the highly developed markets, since fabrics contain all the differences that exist between yarns, and, in addition, all those consequent upon the numerous operations conducted in the weaving shed. Yet we find a rough grading of certain classes of cloth, which the development of machinery is constantly rendering more perfect. Cloths purporting to be the same vary less now that the differences due to human skill have been minimised, and a great uniformity has been introduced in the working of power looms.

"The cloth market is somewhat the same as it was at the end of the eighteenth century. The grey cloth agent, whose function is analogous to that of the yarn agent, is a new feature and the Manchester warehouseman or shipper takes far fewer risks and stocks less in proportion to the business done than did his predecessor a century

ago." The export business in yarns and cloths is principally in the hands of shippers, but there is a certain number of firms who do their own marketing abroad. There is a decided line of difference between the home merchant and the shipping merchant dealing with foreign orders. "Selling through independent merchants' houses," says Chapman, "is to be expected when the commodities dealt in tend to be of sorts that sell themselves, that is, commodities more or less gradable, for which a private market need not be won. Lancashire manufacturers who push their own products over the heads of the merchants are those who produce special classes of goods and depend upon these goods earning and retaining a popularity of their own. When the goods to be sold have to make private markets or when they are complicated and require to be explained to would-be buyers by competent experts there is a tendency for manufacturers to attempt themselves to reach the consumers, or retailers, or the foreign agencies through which such goods can be sold."



SHIPPING COTTON AT NEW ORLEANS

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SHIPPING COTTON AT NEW ORLEANS

CHAPTER VII

TRADES UNIONS AND MASTERS' ASSOCIATIONS

TRADES Unions were formerly, in the eyes of the law, illegal organisations. The unions of the operatives were founded amid difficulty. Preston was the cockpit for many of the early struggles as to wages. Spinners' Associations were formed in Oldham, and other centres, the Oldham Province being established in 1843, and developing into one of the most powerful trades unions in the country. In 1880 the Bolton Association of self-actor spinners united with the old hand Mule spinners' organisation of that town, and the neighbouring associations of cotton spinners and winders coming into line, there was established the Bolton Province. The Amalgamated Association of Operative Cotton Spinners of Lancashire and adjoining counties was constituted in 1853, but it did not become powerful until after 1870, when the new financial basis was laid down. A Union of the Weavers of Great Britain and Ireland had been founded in 1840 when the Stockport strike took place. This proved a very imperfect union. In 1854 the weavers of Blackburn became organised on a sound basis. Other associations were formed in Preston, Darwen, Accrington, Colne, Nelson, and other weaving centres, and in 1884 the various Operative Weavers' Associations became federated in the Northern Counties Amalgamated Associations of Weavers. In 1830 the hands in the card and blowing rooms became organised, and they have grown into a powerful union. Other departments of the textile industry have their associations and amalgamations.

The various branches of operatives are now closely linked for mutual aims, and by International Conferences are becoming sympathetically associated with the operatives of the Continent.

The present organisations of the operatives are: Amalgamated Association of Operative Cotton Spinners; Amalgamated Association of Card and Blowing Room Operatives; Amalgamated Northern Counties Association of Warpers, Reelers, and Winders; Amalgamated Power Loom Overlookers; Bleachers and Dyers; Society of Twisters and Drawers; Society of Cloth-lookers. Then there are the Amalgamated Associations of Slashers and Tapers and other organisations.

The operatives' amalgamations appoint representatives to the Legislative Council of the Textile Workers' Association, which deals exclusively with legislative questions affecting the cotton industry. The various societies are also affiliated with the Trades Union and the Congress of Labour.

At the present time a Trades Federation for offensive and defensive purposes, composed, in some towns at any rate, of weavers, overlookers, slashers, cloth-lookers, twisters and drawers, is being constituted. It is no part of this work to refer to trade disturbance by either strikes or lock-outs. The tendency on the part of both masters and men is in the direction of establishing enduring relationships of peace, based on equitable understandings and instruments.

CAPITAL AND LABOUR—CORDIAL RELATIONSHIPS

In his manifesto of 1904, Mr. Macara said:

"In England, the organisations of both the employers and the operatives are much more complete than in any other country; this has materially improved the relationship existing between capital

and labour, and is greatly to the interests of both. Collective bargaining in a great industry such as cotton is almost a necessity for working it to the best advantage. The margin of profit that is obtainable is not large and it is therefore better that all engaged in it should be on an equal footing as regards wage lists. The leaders of the English cotton operatives are, generally speaking, most intelligent men, and especially during recent years have recognised that they have responsibilities in connection with the maintenance of the industry, and have gladly assisted the employers in forward movements to advance the interests of the industry as a whole. The operatives' organisations have contributed money liberally to assist in such objects as combating the baneful effects of shipping rings; in advancing the interests of the British Cotton Growing Association, and other similar movements; and are at present working with the employers to find some effectual remedy to prevent a recurrence of a similar crisis to that now existing. In the meantime, the operatives are cheerfully submitting to the hardships entailed by the reduced hours of labour so general at present. They have also from time to time joined with the employers in philanthropic efforts, notably in raising large funds for the relief of the famine-stricken natives of India in 1897 and 1900; indeed the relationship existing between capital and labour in England, especially in the cotton industry, might, with advantage, be emulated by all other countries."

This is a striking testimony to the growth of an intelligent, earnest, and high-minded view of the need for collaboration in the interests of peace, whose victories are greater far than those of war.

Representatives of the Employers' Federation are constantly meeting representatives of the Operatives' Associations. These meetings, including meetings between local officials as well as those of the Federation, will total up in any one year to well over 300. One of the most important pieces of work accomplished by the Federation was the settlement arrived at in the year 1893, when the Brooklands Agreement was adopted by various operatives' organisations and the Federation, after a stoppage of the Federation mills lasting twenty weeks in connection with a demand by the employers for a five per cent. reduction in the wages of the operatives on account of the state of trade. This broad and statesmanlike agreement has been the means of preventing scores of strikes, and it is one of the most important factors in the developing of intimate relations between the organisations of the employers and employed. Another important achievement has been the adoption by the Federation and the Operatives' Card and Blowing Room Amalgamation of a universal list of prices and conditions of work in connection with the working of Revolving Flat Cards. This agreement, arrived at after three years' negotiations, has already almost done away with disputes in this department of mill work.

Since 1899 many Conferences between representatives of the Federation and of the Operatives' Unions have taken place to discuss a Conciliation Scheme for the regulation of wages on the basis of a sliding scale, according to the state of trade. This scheme was intended as an addendum to the Brooklands Agreement, and to give effect to the first clause which contains a joint recognition and admission by the two parties that disputes and differences are inimical to their welfare, and that it is desirable that means should be devised and adopted whereby such disputes should be settled

quickly and amicably, and strikes and lock-outs thereby avoided.

In 1909, the Board of Trade, desirous of promoting the negotiations between masters and men, appointed Sir Edward Clarke, K.C., as chairman. There is every hope that, by mutual concessions, there will before long be arrived at the greatly hoped for instrument of an enduring peace. For the moment the negotiations are suspended.

CHAPTER VIII

MASTERS' ORGANISATIONS

THE cotton employers of various districts took early concerted action for the protection of their interests, and each cotton spinning and manufacturing centre has its Masters' Association to-day. These have become amalgamated and federated into very powerful bodies. The principal organisations to-day are the Federation of Master Cotton Spinners' Associations, and the North and North-east Lancashire Associations of Master Cotton Spinners and Manufacturers, one representing the spinning section of the industry, as well as about 80,000 looms, the other the weaving (a few million spindles are also included in this Association). There is also a Parliamentary Association, which was founded in 1899, and which corresponds to the United Textile Workers' Association, composed of delegates from all the textile workers' organisations. The most important of these bodies is the Federation of Master Cotton Spinners' Associations. Twenty-two years ago most towns possessed a Masters' Association. Oldham became the most important, on account of the large number of spindles located there, and it was at length felt by the employers that it was no longer possible for disputes, etc., to be dealt with satisfactorily by one Association, however large. It was decided to form an amalgamation, and in February, 1892, the now famous Federation of Master Cotton Spinners' Associations was established with a membership of seven districts, and embracing firms owning 17,000,000 spindles. Now, in its eighteenth year, it includes thirteen districts, and

40,000,000 spindles. One of the great achievements of the Federation was the construction, as previously mentioned, of the Brooklands Agreement, providing for the adjustment of wages by a peaceful conference. The Federation brought about the short-time movement of 1904, the year of the shortage in American cotton, and disastrous speculation. The same stress compelled the Federation to unite closer together for common support; and, finally, the combined action of speculators as against the spinners of the world in 1904, resulted in the formation of the International Federation. Mr. Travis observed, "The words of our first King Edward in summoning his first Parliament: 'It is a most equitable rule that what concerns all should be approved by all, and common dangers should be repelled by united action,' puts the situation in as concise a form as possible." These words although applied to national affairs are equally applicable to the business of cotton spinning. With good organisation we can do anything in reason. Without it we can do nothing but drift. In the formation of this International Federation the services of Mr. C. W. Macara, President of the English Federation of Master Cotton Spinners' Associations, have been of enormous value. Mr. Macara, taking a most statesmanlike view of the trade's needs, led the movement to bind in one powerful international organisation the spinners of the world, with the view to determine common principles of action. Mr. Travis, in his speech on organisation at Vienna, closed by summarising what was undoubtedly Mr. Macara's ideal. He said: "I maintain that by good organisation, without attempting to exploit either the consumers of our goods, or the workpeople who make them, we have no necessity in the future, as we have so often done in the past, to work our mills for long periods of time for no return at all,

but by concentrated action we shall be able to ensure to a reasonably managed and equipped mill a reasonable profit in a very few months."

In the latter portion of the introduction to this book quotations are made from the historical manifesto to the textile trade of the world issued by Mr. C. W. Macara in 1904. This momentous declaration, with the object of bringing about an international union of users of cotton, was made at a time when the spinning spindles of the world reached the vast total of 104,000,000. Mr. Macara pointed out that the English Federation of Master Cotton Spinners' Associations was the largest in the world, and that it was composed of spinners of both American and Egyptian cotton. He said: "Although England is no longer the largest consumer of American cotton, it is not through any reduction in her consumption of it, but because other countries have developed this industry so greatly, mostly for their home requirements." "There is little doubt that the expansion of cotton machinery throughout the world has been so great that for four successive years the supply of the raw material has been insufficient to run the cotton spindles of the world." The pronouncement went on to gravely refer to the multitude of disasters which attended the dislocation of trade through the paralysing inflations of cotton prices brought about by speculations which produced sudden and violent fluctuations. "To endeavour to bring about an international union of users of cotton is a work well worthy of a serious attempt, for no combination of holders of any raw material can long stand against a combination of users of that raw material." He pointed to what the English spinners had done, in bringing down cotton prices, by limiting production at times of crisis, and observed: "The recognition of an absolute

community of interest should clear the path of all difficulties in the way of a speedy development of international action." He pointed to the imperative need, for the protection of the interest of the spinner, of absolutely reliable statistics being obtained of the annual consumption of cotton, stocks in the hands of spinners at stated periods, and of the cotton crops of the world. Once that was obtained, the gambler's opportunity vanished. The English organisations are much more complete than those of the European Continent and America, and Mr. Macara advocated that whilst the Continental and American Associations are perfecting their organisations an International Congress of the Associations of Cotton Spinners might result in some scheme being devised for joint action being taken in many ways. Then he recites the first practical step towards the international movement.

The year 1903 was one of the most harassing to all responsible for conducting the cotton trade. There was a great shortage of cotton, and an insufficiency of the raw materials of other textile industries, and extensive speculations.

The commencement of the international movement, which was the outcome of Mr. Macara's wide view of the imperative needs of the trade, was a meeting of the General Committee of the Federation of Master Cotton Spinners' Associations at Manchester on December 16th, 1903, when it was decided to send to all Continental and American Associations of cotton spinners a cablegram stating that Lancashire suggested short time in the cotton trade all over the world to check speculation in the raw material, and asking if they were prepared to adopt a similar course, limiting running to forty hours per week. Subsequently a great mass meeting of employers in all sections of the Lancashire cotton

trade and representatives of the operatives (who were on the platform and spoke) was held in Manchester on December 29th, 1903, and addressed by Mr. Macara, who exhorted the meeting to calmly consider whether it was possible to devise some means to avert the terrible suffering that appeared imminent through the cornering of the raw material by gamblers. Thirty years before, when the entire cotton crop of America averaged only three and a half million bales, and Lancashire consumed three-quarters of it, such a situation as that confronting them could have been effectively dealt with. Since 1873 " the American cotton crop instead of averaging, as it then did, 3½ million bales, now averages about 11,000,000 bales, and such has been the development of the cotton industry throughout the world that an international combination to reduce the consumption of cotton is necessary if the existing position is to be effectively dealt with." American and Continental spinners being engaged in the production of coarser fabrics consequently use much more cotton per spindle than does the English spinner. M. Casimir Berger, Vice-President of the French Spinners' Association, was present at the meeting, and in reply to the cablegram messages were read from various Continental Associations of Cotton Spinners and Manufacturers showing that production was being limited and indicating a desire to fall into line as far as possible in limiting production. Mr. Macara, after reciting these proceedings in his manifesto to the trade of the world and referring to the limitation of production to forty hours per week in English mills shows how after the great mass meeting in Manchester in December, 1903, he drafted and submitted to the entire body of British Master Cotton Spinners a scheme whereby uniform action might be arranged in order to thwart the persistent manipulations by cotton

gamblers. Though the scheme was not adopted, the system of organised short time had been applied with marked success by the Federation of Master Cotton Spinners' Associations in England, and has been adopted as occasion arose, by every cotton-using country in the world. Mr. Macara enforced the supreme importance of opening out new cotton fields. In January, 1904, the then Prime Minister of England, the Rt. Hon. A. J. Balfour, received in Manchester a deputation of employers and leaders of the operatives representing the English cotton industry, the object being to discuss the possibility of taking steps to check gambling in cotton. The loss sustained in operatives' wages was computed at two million pounds sterling; that by workers in subsidiary and dependent industries, two millions, and that by the employers two millions. The first suggestion to Mr. Balfour was to summon an international congress; the second, to obtain information as to the supply of raw materials by experts appointed by the Board of Trade. After giving due consideration to these matters Mr. Balfour did not see his way to adopt the suggestions, and the English Federation of Master Cotton Spinners' Associations, in conjunction with the Swiss Cotton Spinners' Association, next decided to summon a Congress of Master Cotton Spinners' Associations of Europe and America to consider what steps were to be taken to prevent the violent fluctuation and the high prices of raw cotton. Impressive evidence is cited by Mr. Macara, in his address to cotton employers of the world, of the effect of checking production in England. He says:

"In 1903 when 'full time' was being worked, the deliveries amounted to 890,000 bales—an average of 69,000 bales per week for the three months. In

1904 during the corresponding three months, the deliveries were 582,000 bales—an average of 45,000 per week. During the latter period, by the action of the Federation of Master Cotton Spinners' Associations, a large percentage of spinners using American cotton—a section representing two-thirds of the entire English cotton spinning industry—were running 'short time,' and the demand for American cotton as a consequence, fell off practically one-third of that of the former year, *i.e.*—300,000 bales for the three months, or at the rate of 1,200,000 bales per annum. The total number of spindles using American cotton, running 'short time' in England, probably equals the total number of spindles using American cotton on the Continent of Europe, or in the Northern and Southern States of America. From the foregoing it will readily be seen what effect would have been produced by a combination of spinners throughout the world, using American cotton, joining in this *short time* movement and so reducing the consumption by one-third as has been done in England; especially as the spindles both on the European continent and in America are engaged on much coarser counts and therefore consume a much greater weight of cotton per spindle than those in England. It is obvious that the effect would have been such that no combination to raise the price of the raw material could have long withstood such a reduction in the demand by the users of it. Another striking result of the *short time* movement in England is that the supply of manufactured goods has been kept within the limits of the demand."

Mr. Macara offered as suggestions for the first International Congress (1) The work of perfecting organisation. (2) The establishment of an International Intelligence

Department. (3) The bringing of spinner and planter into more direct contact. (4) International Legislation to prevent the abuse of speculative dealing.

In May, 1904, the first International Congress was held at Zurich. The Swiss Association of Cotton Spinners and Manufacturers had readily acted with the English Master Cotton Spinners' Federation as joint conveners of the Congress. Nine nationalities were represented and on the nomination of Mr. Macara, who expressed intense satisfaction at the magnificence of the response, Herr John Syz, President of the Swiss Association, presided. The note of the Congress was soon struck, " To safeguard legitimate trade," and Mr. Macara enforced the supreme value of the federation of forces national and international, to promote the healthy evolution of trade. The question of cotton growing in the colonies, possessions, and dependencies of European countries was a prominent object of discussion here, as it has been at the subsequent congresses, and the Governments of the world were asked by a resolution of the Congress to promote the growing of cotton for the preservation and development of the cotton industry. Resolutions were also passed urging the Governments to take steps to check cotton speculations by those outside the trade. An International Committee was appointed and Mr. Macara was elected Chairman.

The second Congress was held at Manchester and Liverpool in 1905. The address of Mr. Macara, as President, brought out the magnitude of the cotton industry in clothing the inhabitants of the world. " The annual average price of the cotton crop of the world has varied during the past ten years from under 4d. to as high as 7d. per pound, but taking an average of 5d. per pound, and estimating the annual crop of the world at 16,000,000 bales of 500 lb. each, the value of the raw material

would amount to £160,000,000. In England, where the cotton industry is more highly specialised than elsewhere, the cost of converting the raw material, when at an average of 5d. per pound, into finished fabrics is over one and a half times the original cost, so that although less may be spent by other countries in manipulating the raw material, the annual value of the fabrics produced from cotton must be about £350,000,000." He enforced the need for the development of new fields to increase the sources of supply. He dwelt upon the imperative need of the Federation having its own estimate made of the cotton crop of the world. The purchase of cotton, damp in cotton, and the metric system of weights and measures were all well discussed. The value of the Conference was speedily apparent. The first resolution dealt with the careless baling of cotton, involving loss on users, and urging united action to secure a remedy. Damp in cotton was discussed, and a further resolution declared the need of securing a more equitable basis between the buyer and the seller.

The third Congress was at Bremen in 1906. It was abundantly clear that having mitigated the difficulties of a trying time by the adoption of short time running and prepared the way for subsequent prosperity, the Federation had justified its existence. The International Committee had during the year held meetings in London, Paris, and Berlin, and had received every help and courtesy from the heads of states. It was in Paris that the Committee decided to secure the support of their several Governments to the scheme inaugurated by the King of Italy for the establishment of an International Agricultural Institute, which is bound to be of great value to the cotton and kindred industries. The Congresses, too, it was shown had stimulated the work

of the European Colonial Cotton Growing Associations. The results of the Lancashire Private Cotton Investigation Commission appointed a few months previous to the Bremen Congress, by a number of leading English firms, to investigate the conditions under which American cotton is grown, marketed and transported, were submitted in a paper by Mr. H. W. Macalister, Chairman of the Commission, who showed that there is an unlimited field for the cultivation of cotton in the Southern States. The Report which had been prepared by the Commission and distributed throughout the world created a profound impression. The Commission attended a Conference of Planters and Spinners in Washington. The main interest of the spinners in the American Conference had been to urge and endeavour to bring about improvements in the growing and handling of cotton, and they found a ready response from the growers. The discussions encompassed questions as to cotton growing, rules of exchanges, etc., and the growing magnitude and value of the work of the Congress was abundantly manifest. His Imperial Majesty, the Emperor of Germany, graciously received the Committee at Kiel, and manifested considerable interest in the international movement in furtherance of its aims.

The fourth Congress was at Vienna in 1907, where the delegates had a gracious reception from the Emperor of Austria. Since the Bremen Congress the Committee had had the honour of being received and entertained at Windsor Castle by King Edward the Seventh, who was accompanied by Queen Alexandra and Princess Victoria, so that during the three years that had elapsed since the inauguration of the International Movement, the members of the Committee had been similarly honoured by the heads of four European nations—France, Germany, England, and Austria. Japan joined

the Federation at this Congress. The Cotton Contract Commission formulated their proposals and a series of discussions of supreme interest to the trade followed.

The fifth Congress was held at Paris in 1908, the Committee being received by President Fallières at the Elysée. It was made clear that considerable progress had been made during the year as to broadening the sources for the supply of the raw material; efficient ginning, baling, and transport; the new form of cotton contract, an improved bill of lading, mill fire insurance, organisation, statistics, etc. At this Congress Mr. Moritz Schanz read a most valuable historical, scientific, and statistical paper on cotton growing in the United States of America, not only dealing with the systems of cultivation and harvesting, but of forwarding and shipping; the extraction of oils from the cotton seeds, and the consequent subsidiary industries. The origin and development of the factory system in the United States was an interesting chapter in this most compendious and well constructed paper.

The great event between the fourth and fifth Congress was the attendance of a large European delegation at the Conference of cotton planters and spinners held at Atalanta, Georgia, U.S.A. Here the planters met face to face representative spinners, manufacturers, and cotton exchange men from practically all over the world. The Conference did much to expedite reforms in ginning, baling, and in the storage and handling of cotton.

The sixth Congress, held in 1909, was in Milan, and a few days before, in Rome, His Majesty the King of Italy graciously received the members with great cordiality. Here, again, particulars of the progress of the Federation were found in the addresses delivered, and the records of British and foreign cotton growing were very satisfactory. The obligations felt by all the

members of the Federation to restrict production from time to time to meet the perils and disasters of cotton shortage and speculation, have been again and again demonstrated and never more so than in the trials which afflict the trade through cotton shortage and speculation at the close of 1909. The returns received by Mr. Schmidt, the Secretary of the International Federation, prove a patriotic adhesion to the sound principles of restriction to deal with shortages in the raw material. The great event of the Milan Congress was the official association of the International Cotton Federation with the International Institute of Agriculture, founded by the King of Italy at Rome. The beautiful building for carrying on the work of the latter was erected by His Majesty, and opened by him in May, 1908. It was an enormous advantage to this institute that the sympathy of Mr. Macara and through him that of the International Federation was enlisted by Mr. Lubin, who had made a pilgrimage of the capitals of Europe and received little encouragement. The accession of the help of the Federation which recognises practically the natural alliance of the Agricultural and Textile Arts has been of enormous value, and illustrates, historically, the economic interdependence of nations, *Finis Coronat Opus.*

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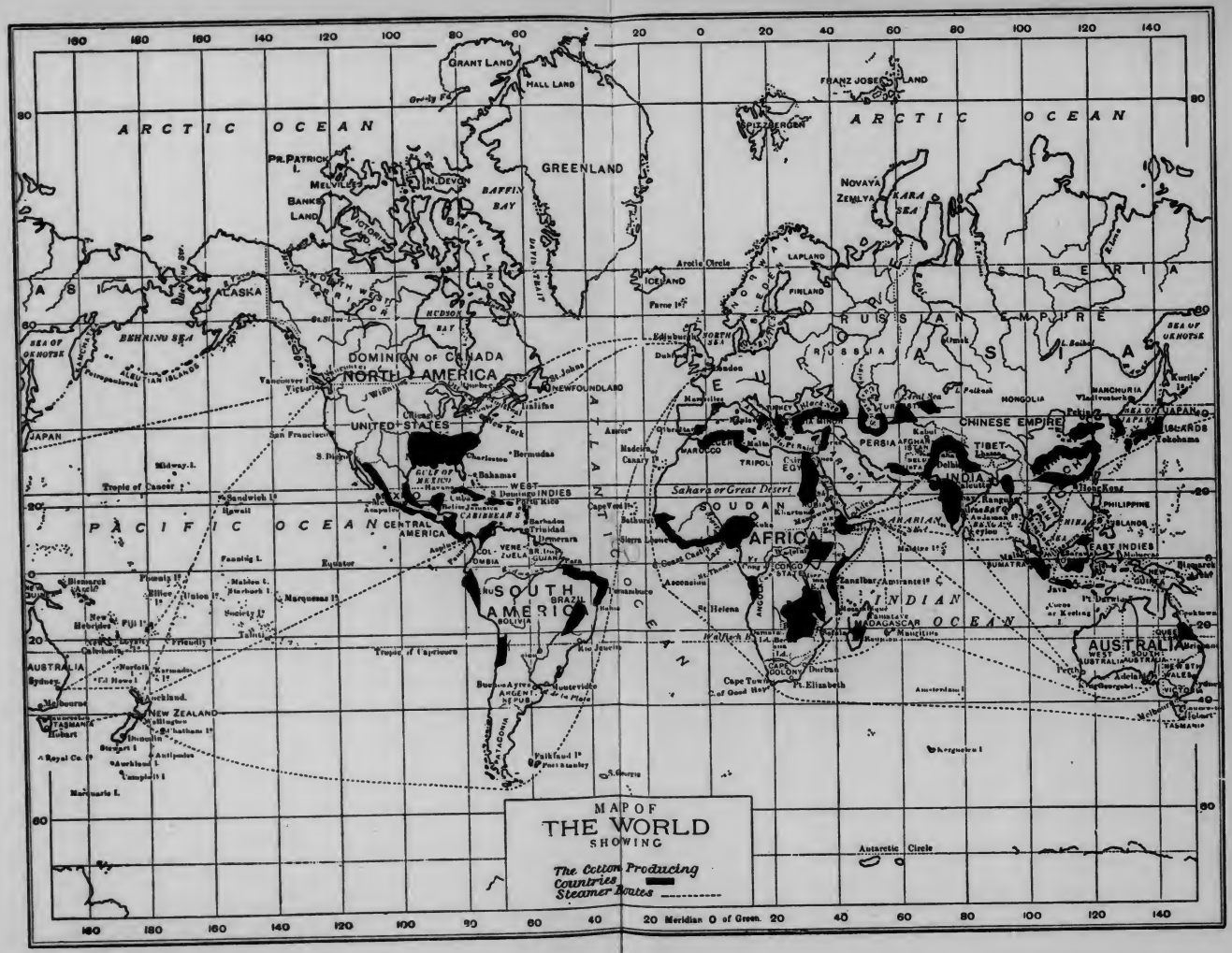
ARCTIC OCEAN
GRANT LAND
HALL LAND
GREENLAND
FRANZ JOSEF LAND
SPITZBERGEN
NOVAYA ZEMLYA
KARA SEA
ASIA
SIBERIA
RUSSIAN EMPIRE
RUSSIA
LAPLAND
ICELAND
FINLAND
Arctic Circle
BAFFIN BAY
DAVIS STRAIT
HUDSON BAY
BEHRING SEA
ALASKA
DOMINION OF CANADA
NORTH AMERICA
UNITED STATES
NEWFOUNDLAND
MONGOLIA
MANCHURIA
CHINESE EMPIRE
PERSIA
TIBET
INDIA
JAPAN
ISLANDS
PHILIPPINE
EAST INDIES
SUMATRA
Sahara or Great Desert
SOUDAN
AFRICA
ARABIAN SEA
INDIAN OCEAN
MADAGASCAR
PACIFIC OCEAN
CENTRAL AMERICA
WEST INDIES
SOUTH AMERICA
BRAZIL
AUSTRALIA
NEW ZEALAND
Equator
Tropic of Cancer
Tropic of Capricorn
Antarctic Circle
Meridian 0 of Green.
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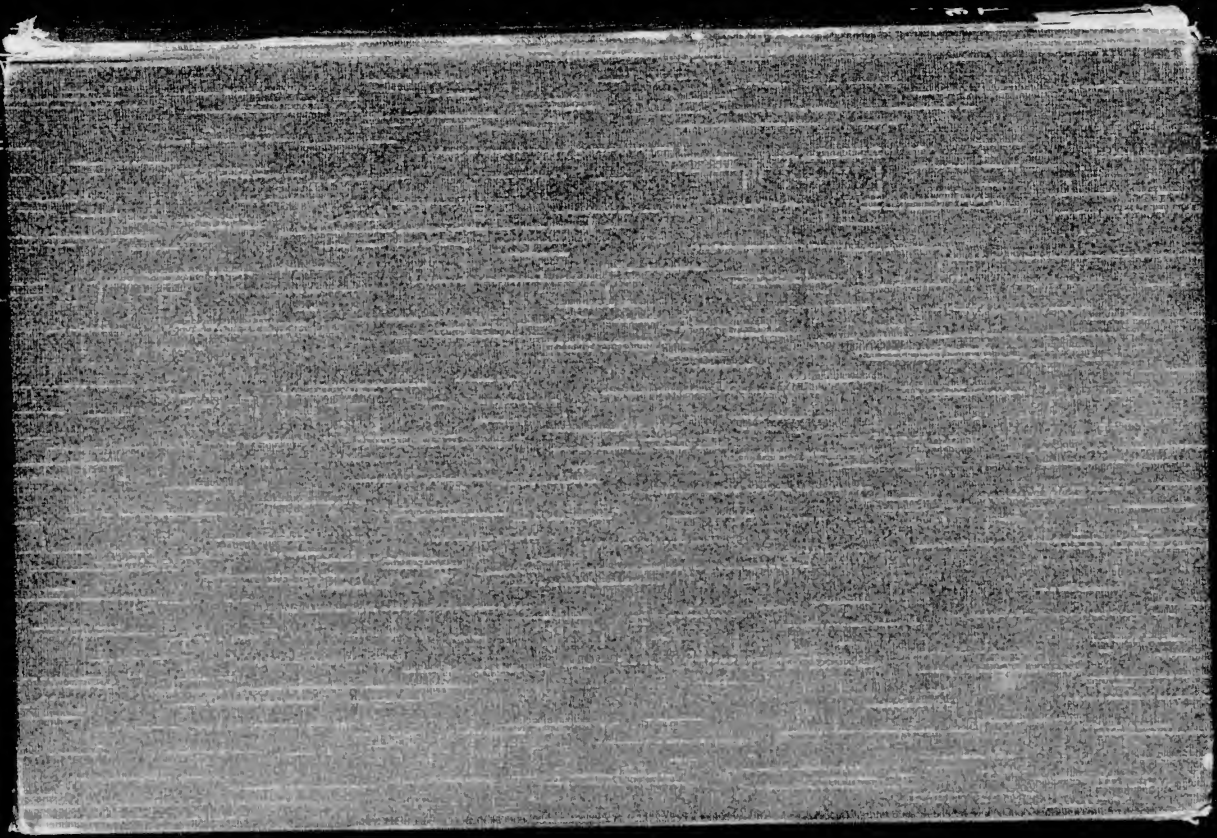

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